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ABSTRACT

This curriculum guide is intended to provide vocational agriculture instructors with an up-to-date resource dealing with grape production in Washington. Addressed in the individual units of the guide are the following topics: the history of grape production; grape types important to Washington; site selection for a vineyard; establishment and production costs; propagation methods, nursery stock, soil preparation, and planting; fertilization and nutritional grape disorders; critical temperature and frost control; grape pests and pest control; methods to improve grape quality; training, pruning, and trellising; irrigation; harvesting; and processing and marketing. Each unit contains some or all of the following: introductory instructional text, a unit goal, unit objectives, a unit content outline, suggested activities, an information sheet, a list of references, transparency masters, a unit test, and answers to the test. A 28-item bibliography concludes the guide. (MN)

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A GRAPE PRODUCTION GUIDE FOR VOCATIONAL AGRICULTURE INSTRUCTORS IN WASHINGTON STATE

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1984

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A GRAPE PRODUCTION GUIDE
FOR
VOCATIONAL AGRICULTURE INSTRUCTORS IN WASHINGTON

FINAL REPORT

Project No. 84-ATJ(186)NB

Curriculum Development Project
Conducted Under Public Law 94-482

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1984

Research Coordinating Unit
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PREFACE

A Grape Production Guide was developed to assist teachers of vocational agriculture with an up-to-date, easy to use resource dealing with grape production in Washington. This guide is divided into units representing major areas in the grape industry and conveniently includes an introduction, information sheet, test and answer sheet for each unit.

Stewart Padelford has developed an excellent curriculum guide which will enable teachers to provide instruction to their students about the grape industry. This curriculum guide along with many extension bulletins published by Washington State University and other universities can supply much of the subject matter information needed by the teachers and his/her students.

I am confident that many agricultural instructors will find the manual an invaluable aid in teaching grape production on the secondary level.

J.C.

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Special recognition is given to Mr. Stewart Padelford who developed the "Grape Production Guide for Vocational Agriculture Instructors in Washington State," as part of his Master's Degree in Vocational Technical Education.

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Mr. Stewart Padelford, Vocational Agriculture Instructor, Grandview

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Introduction

Unit I

Grapes, the most important fruit in the world, account for over one quarter of the world's fruit crops. The diversity of uses for the fruit are its fortay. The fruit can be consumed as fresh table grapes, dried for raisins or pressed into juice or wine.

Washington is the leading state in America type grape production of which the variety Concord makes up 80-90 percent of this total. Washington's wine grape industry is listed as the 3rd most important in the United States. Combined acreage for the two segments of the grape industry totaled approximately 28,000 acres. Concords make up over 20,000 acres while European type grapes make up most of the remaining acreage.

The growth of the grape industry particularly in the wine grape segment, has brought about an additional need for skilled labor, managers, chemical and fertilizer applicators, marketing agents, fieldmen, nurserymen, warehousemen, and equipment operators. The importance of the industry to the state's economy cannot go unrecognized. Vocational Agriculture classes must be concurrent with the needs of the industry.

History of Grape Production

Unit II

Unit Goal: The student will develop an understanding of how grape production expanded in the United States and Washington State.

Unit Objectives: Upon completion of the unit, the student will be able to:

1. Describe the affect European settlers had on the history of the United States grape industry.
2. Explain the adaptation of grape types to various areas of the United States.
3. Explain the beginning of grape production in Washington State.
4. Explain the emergence of grape production in the Yakima Valley.
5. List the major changes in liquor laws that affected the growth of the wine grape industry.

Unit Content Outline:

I. Grapes in temperate zone.
    A. One of the oldest fruits.
    B. Used as:
        1. raisins.
        2. fresh fruit.
        3. juice.
        4. wine.

II. Grapes in America.
    A. Europeans.
        1. European types in Northeast.
            a. failure.
    B. Indians.
        1. American types.
    C. American and French Hybrids.
    D. California.
        1. European types.

III. Grapes in Washington State.
    A. Puget Sound.
        1. 1872.
            a. Stretch Island.
            b. Lambert Evans.
            c. Vitis Lambrusca Cultivars.
        2. 1890.
            a. Grape nursery.
            b. Adam Eckert.
    B. Yakima Valley.
        1. 1906.
            a. irrigation canals.
            b. commercial plantings of Vitis Labrusca.
        2. 1880.
            a. Union Gap.
            b. Dryland Vitis Vinifera.

3. 1930.
    a. W. P. Bridgeman.
    b. White Riesling Grapes.
4. 1936.
    a. Bottles White Riesling.
    b. Upland Winery in Sunnyside.

C. Repeal (subsequent).
  1. 42 wineries.
  2. Postwar slump of 1940.
  3. 1950 - Beginning of Current Vitis Vinifera.
      a. Grenache and White Riesling.
          i. Varietal
          ii. Generic
  4. 1969 - Liquor law revision.
      a. Increased interest.
      b. Table wine consumption in mid-1970s.

Suggested Activities:

--Field trip - Upland Winery - Sunnyside, Washington.

Information Sheet

History of Grape Production

Used for fresh fruit, raisins, juice and wine, the grape has proven itself as one of the most diverse fruits in the temperate zone.

Europeans, who came to America as traders, settlers, and missionaries introduced the European type grapes or Vitis vinifera grapes to the northeast. These plantings met with little success. Severe cold weather and diseases destroyed many of the Vitis Vinifera plantings. Indians had already adapted varieties to the northeast now commonly referred to as American type grapes or Vitis Labrusca. Crosses have been made between European types and American types to get American and French hybrids. These varieties are common to the northeastern United States.

European varieties found the warm, dry climates of California quite acceptable. They are now the basis for the wine, fresh table grape, and raisin industries of the state of California.

Vitis Labrusca were the first grape types introduced to Washington State. In 1872, Lambert Evans planted the first grapes on Stretch Island in the Puget Sound. By 1890, Adam Eckert had started a grape nursery located in the same area.

Due to the development of irrigation canals in the Yakima Valley, the first commercial plantings of Vitis Labrusca were introduced in the early 1900s. Earlier plantings on dryland had taken place near Union Gap in 1880 with Vitis Vinifera cultivars. W. P. Bridgeman bottled the first wine in eastern Washington

State in 1936 at his Upland Winery in Sunnyside. The White Riesling variety had been planted in 1930 in a Bridgeman vineyard near Sunnyside.

After the Repeal of Prohibition, some 42 wineries began in the state. The start of World War II slowed the wine industry tremendously.

The 1950s brought with it the current European vineyards of Washington State. The first Grenache and White Riesling were unsuccessful as generic wines but succeeded as varietal wines and were bottled as Johanisberg Riesling and Grenache Rose'.

Again, in 1969, liquor law revisions in Washington brought increased interest to table wines. Table wine consumption in Washington State in the mid-1970s increased from 1.5 gallons to 3.0 gallons per capita.

References

Clore, Walter J. and Ronald B. Tukey. "Grapes--Their Characteristics and Suitability for Production in Washington." Extension Bulletin 635, Cooperative Extension, Washington State University, Pullman, Washington.

Klein, Joel K. "Wine Production in Washington State." Chateau Ste. Michelle, Woodinville, Washington.

Weaver, Robert J. "Grape Growing." John Wiley and Sons, New York, New York.

Test Name _______________

History of Grape Production

1. Match:

____a. Vitis Vinifera

____b. Lambert Evans

____c. W. P. Bridgeman

____d. Indians

____e. Irrigation Canals

____f. Liquor law revisions of 1969

____g. Union Gap

____h. California

____i. American hybrids

____j. Adam Eckert

1. Remnants of first dryland Vitis Vinifera vineyards.

2. Introduced to the northeast by European settlers.

3. Crushed White Rieslings in 1936 at Upland Winery, Sunnyside.

4. Brought about the first commercial plantings of Vitis Labruscas.

5. Brought a subsequent increase in table wine consumption from 1.5 gallons to 3 gallons per capita in the mid-1970s.

6. Planted the first grapes in Washington State in 1872.

7. Vitis Vinifera cultivars are the basis for grape industry.

8. Had cultivated the Vitis Labrusca when European settlers came.

9. A cross between European and American varieties.

10. Had the first grape nursery in Washington State.

2. Select the following statements which are correct:

    ____a. Varietal wines were quite successful in the 1950s.

    ____b. The introduction of irrigation canals was accompanied by the Vitis Labrusca grape in the Yakima Valley.

    ____c. Cold and disease prevented the European grape from being successful in the northeast.

    ____d. Per capita wine consumption doubled in the mid-1970s.

    ____e. The Repeal of Prohibition failed to stimulate the growth of the wine grape industry.

3. List the three grape types:

    a.

    b.

    c.

4. List the changes in liquor laws that affected the growth of the wine grape industry.

    a.

    b.

5. Essay - 5 points.

    Explain the introduction of grapes to Washington State.

Answer Sheet

History of Grape Production

1. 2 a.

   6 b.

   3 c.

   8 d.

   4 e.

   5 f.

   1 g.

   7 h.

   9 i.

   10 j.

2. b, c, d.

3. a. American (Vitis labrusca)

   b. European (Vitis vinifera)

   c. Hybrid

4. a. Repeal.

   b. Liquor law revisions of 1969.

5. Grapes were first planted in the Puget Sound area by Lambert Evans. The introduction of irrigation canals brought the first commercial plantings of American grape types to Central Washington. W. P. Bridgeman crushed the first wine in 1936 at Upland Winery in Sunnyside.

Grape Types Important to Washington State

Unit III

Unit Goal: The student will become familiar with the grape types important to Washington State.

Unit Objectives: Upon completion of the unit, the student will be able to:

1. List the two types of grapes important to the state of Washington.
2. Describe the characteristics of American and European.
3. List limitations and strengths of American and European.
4. Compare the relative uses of the two types of grapes important to Washington.

Unit Content Outline:

I. Grape Types.
    A. European.
    B. American.
II. European type - Vitis Vinifera.
    A. Characteristics.
        1. Non-slip skins.
        2. Mild flavor.
        3. Vigorous growth.

B. Limitations.
   1. Disease.
   2. Cold.
   3. Growing season.

C. Strengths.
   1. Heat.
   2. Sandy and infertile soils.
   3. Soils of high acidity.

D. Uses.
   1. Wine.

III. American Type - Vitis Labrusca.

A. Characteristics.
   1. "Foxy" (tart) flavor.
   2. Slip skin.
   3. Moderate growth.

B. Limitations.
   1. None of significance.

C. Strengths.
   1. Early maturing.
   2. Very productive.
   3. Resistant to cold and disease.

D. Uses.
   1. Juices and jelly.
   2. Wine.
   3. Fresh table grapes.

Suggested Activities:

--Study mature berry clusters of each of the two grape types, compare the skins and flavor of the grapes.

--Observe and compare the growth habits of the two grape types.

--Discuss and show grape products for grapes.

Information Sheet

Grape Types Important to Washington State

Grapes, for thousands of years, have been sources of fresh fruit, dried raisins, and juices for wine.

The two most important grape types to Washington State are the Vitis Vinifera or European type and the Vitis Labrusca type or American type.

The European types remain the basis of the table grape, raisin, and wine industries of California. European type grapes were first introduced into the eastern United States, but they were unsuccessful because of their susceptibility to cold and disease. Vitis Vinifera, characteristically, have non-slip skins and are relatively mild flavored. They are usually adaptable to heat, sandy soils, and soils of high acidity. Their vigorous growth under a myriad of various soils and climatic conditions make them extremely susceptible to winter temperatures of zero and below. European grapes tend to show a greater degree of susceptibility to disease than do American type grapes. Mildew tends to be a problem in vineyards with limited air movement. Nematodes have also been pinpointed as a major problem. Nematodes will be discussed in Unit IX.

Vitis Vinifera types are the primary grapes used by the wine industry in Washington State. The increased consumption of table wines has brought about an accelerated interest in raising these varieties in central Washington.

The major wine grape varieties grown in Washington State are:

White Varieties
White Riesling
Chardonnay
Chenin Blanc
Gewurstraminer
Semillon
Sauvignon Blanc
Muscat

Red Varieties
Carbernet Sauvignon
Merlot
Pinot Noir
Grenache

The American type grape developed in the eastern United States is considerably hardier and more disease resistant than is the Vitis vinifera grape. A slippery skin, "foxy" flavor, and aroma are characteristics of the Vitis labrusca type. Washington State is the leading concord producer in the United States with about 203,000 tons or around 50 percent of the U. S. total production. (California produces around 90 percent of the total grape tonnage in the United States with Washington, New York, Pennsylvania, and Michigan as other leading producing states.)

Concords, the most popular variety, make up 80-90 percent of the total Vitis Labrusca production.

Concords are quite popular American in central Washington because they are adaptable to most soil and climatic conditions there. Niagras are also of some ecomomic importance in Washington. Washington's production per acre is nearly twice as high as any other state in the nation. The American grape is marketed in three ways:

(1) juice and jelly; (2) wine; and (3) fresh. Marketing will be covered in more detail in Unit XIV. Refer to Table 1 for grape groupings by vigor and maturity.

Table 2 lists grape varieties by type showing berry color and uses.

Table 1. Grouping of Grapes by Vigor and Maturity.

Vigor Group	Vine Vigor	Grapes
A	Medium	American Varieties--Early to medium-early: Concord, Campbell Early, Diamond, Delaware, Niagra
		European Varieties--Early: Pinot noir, Gewurtztraminer, Muscat
B	Medium High	European--Early to medium-early: Cabernet Sauvignon, Chardonnay, Semillon, White Riesling, Chenin blanc
C	High	European--Medium-early to medium-late Wine types: Grenache, Zinfandel, French Colombard, Grey Riesling
		Table types: (also used for blending) --medium-late: Black Monukka, Early Muscat, Thompson Seedless

Courtesy WSU

Table 2. Characteristics of Grape Varieties by Color and Use.

Type and Variety	Berry Color	Uses*
American		
Bath	Blue	T,J,W
Buffalo	Blue	T,J,W
Campbell Early	Blue	T,J,W
Concord	Blue	T,J,W
Delaware	Red	T,J,W
Diamond	White	J,W
Dutchess	White	J,W
Eumelan	Blue	J,W
Himrod (seedless)	White	T,J,W
Interlaken Seedless	White	T,J
Naples	Red	T,J,W
Niagra	White	T,J,W
Romulus (seedless	White	T,J,W
Seneca	White	T,J,W
Schuyler	Blue	T,J,W
Van Buren	Blue	T,J,W
Vergennes	Blue	W
European		
Barbera	Blue	PW
Black Monukka (seedless)	Blue	T,J,W
Cabernet Sauvignon	Blue	PW
Chardonnay	White	PW
Chauche noir	Blue	PW
Chauche gris	White	PW
Chenin blanc	White	PW
Csaba	White	T,PW
Delight (seedless)	White	T,J,W
Early Burgundy	Blue	PW
Early Muscat	White	T,J,PW
French Colombard	White	PW
Gamay Beaujoiais	Blue	PW
Gewurztraminer	Red	PW
Grenache	Blue	PW
Grey Riesling	White	PW
Helena	White	PW
Limberger	Blue	PW
Melon	White	PW

Table 2. Characteristics of Grape Varieties by Color and Use. (continued)

Type and Variety	Berry Color	Uses*
Merlot	Blue	PW
Meunier	Blue	PW
Muller-Thurgau	White	PW
Muscat Hamburg	Blue	W
Muscat Ottonel	White	PW
Nebbiolo	Blue	PW
Palomino	White	T,W
Petite Sirah	Blue	W
Pinot Blanc	White	PW
Pinot gris	Red	PW
Pinot noir	Blue	PW
Royalty	Blue	J,W
Rubired	Blue	J,W
Sauvignon Vert	White	PW
Semillon	White	PW
Sylvaner	White	PW
Thompson Seedless	White	T,J,W
White Riesling	White	PW
Zinfandel	Blue	PW

Courtesy WSU

* Uses: T=Fresh or Table; J=Juice; W=Wine; PW=Premium Wine.

Clore, Walter J and Ronald B. Tukey. "Grapes--Their Characteristics and Suitability for Production in Washington." Extension Bulletin 635, Cooperative Extension, Washington State University, Pullman, Washington.

Clore, Walter J. and Ronald B. Tukey. "Grape Varieties for Eastern Washington." Extension Circular 394, Cooperative Extension, Washington State University, Pullman, Washington.

Weaver, Robert J. "Grape Growing." John Wiley and Sons, New York, New York.

Name____________________

Test

Grape Types Important to Washington State

1. Match.

____ a. Vitis Vinifera

____ b. Wine

____ c. European grape type

____ d. Cold winters

____ e. Slip skin

____ f. Vitis Labrusca

____ g. "Foxy"

____ h. Concord variety

____ i. Juices and jellies

1. The flavor of American type grapes.

3. Vigorous vine growth.

4. Primary use of American type grapes.

5. Scientific name for the European type of grape.

6. Characteristic skin of American type grapes.

7. Scientific name for the American type of grape.

8. Primary use of European type grapes in Washington State.

9. American type grape has the greatest capability of the tyree grape types to withstand this.

2. Select the following statements which are correct:

____a. American grape types is primarily used for wine.

____b. European grape varieties tend to be quite susceptible to diseases and cold winters.

____c. European grape varieties are generally more adaptable to heat, sandy soils, and soils of high acidity.

____d. Washington's European type grape production per acre is nearly twice as high as any other state in the nation.

3. Describe three characteristics of:

   a. American type grape -

   b. European type grape -

4. List three strengths of:

   a. American type grape -

   b. European type grape -

5. List three limitations of Vitis Vinifera grapes.

6. Essay (5 pts.)

   Compare the uses of the two most important grape types of Washington State.

Answer Sheet

Grape Types Important to Washington State

1. 5 a.
   8 b.
   3 c.
   9 d.
   6 e.
   7 f.
   1 g.
   2 h.
   4 i.

2. b, c

3. a. 1. "Foxy" flavor.
      2. Slip skin.
      3. Moderately vigorous growth habits.

   b. 1. Mild flavor.
      2. Non-slip skin.
      3. Vigorous growth habits.

4. a. 1. Early maturing.
      2. Extremely productive.
      3. Resistant to cold and disease.

   b. 1. Adaptable to sandy, infertile soils.
      2. Adaptable to soils of high acidity.
      3. Adaptable to extreme heat.

5. 1. Susceptible to disease.
   2. Susceptible to cold winter temperature.
   3. Not adaptable to a short growing season.

6. American grapes are primarily used in the production of juices and jellies. The remainder is used as fresh table grapes or in wines. European grapes are used in wine production.

Site Selection

Unit IV

Unit Goal: The student will understand the considerations necessary in selecting a location for a vineyard.

Unit Objectives: Upon completion of the unit, the student will be able to:

1. Define length of growing season.
2. Define accumulated heat units.
3. List the length of the growing season for the three grape types.
4. State the importance of accumulated heat units.
5. Interpret and explain data as seen in tables listed in Unit IV.
6. Describe the affect low and high elevations have on grapes.
7. List the item that is affected by change in slope.
8. List the items that are affected by an increase in horizontal radiation.
9. Describe the soil texture and fertility level that is recommended for the three grape types.
10. Describe the soil depth and drainage needed for grapes.
11. List the grape type that is resistant to pH of over 8.

Unit Content Outline

I. Climate.

    A. Length of growing season.

        1. American types.

            a. 165 days to maturity.

        2. European types.

            a. 175 days to maturity.

    B. Accumulated heat units.

        1. Mean temperature above 50°F times the number of days per month from April 1 through October 31.

        2. Quality of grapes.

        3. Maturation of grapes.

II. Elevation and Slope.

    A. Air drainage.

        1. Prevent "frost pockets."

    B. South facing slope.

        1. Increases radiation reception.

        2. Increase in sugars.

III. Soil and Fertility.

    A. Vitis vinifera.

        1. Low fertility.

        2. Shallow, sandy loam.

            a. controls vigor.

            b. favors hardening off.

B. Vitis labrusca.
    1. Deep soil.
    2. High fertility.
    3. Medium textured soils.

C. Non-Calcareous deep soil.

D. Saline soils.
    1. Affects quality.
    2. Affects yield.
    3. Causes.

Suggested Activities:

--Determine soil depths, texture, and fertility of the school vineyard or vineyards near your school. Make recommendations as to the varieties that could be grown in that soil.

--Determine the varieties of grapes that could be grown in different locations throughout the state according to the length of growing season and accumulated heat units.

Information Sheet

Site Selection

Grape producers have commonly used natural factors when selecting a vineyard location.

The climate is extremely important as it dictates the type of grape and in many instances the variety of grape that can be grown.

The two most important climatic consideration are the length of the growing season and the accumulated heat units. For example, American type grapes will mature in 165 frost free days while vinifera types require as many as 175 days, depending upon the variety.

Further information can be found in Table 3.

Table 3. Relationship Between Length of Growing Season and Performance of Grapes.

Length of Growing Season, Number Frost-Free D[illegible]	Performance of Various Type Grapes*	
	American	European
Under 140	Marginal	Unsuitable
140-150	Good	Unsuitable
150-160	Preferred	Marginal
160-170	Preferred	Fair
170-180	Good	Good
Over 180	Satisfactory	Preferred

(Courtesy WSU)

*Performance of selected varieties

Transparency Master 1 shows the mean number of frost-free days (32°) for various areas of Washington State.

Refer to Transparency Masters 2-4 for the adaptation of specific varieties to various levels of Degree Day Heat Units.

Years of experience in commercially raising American type grapes has helped identify ideal climatic conditions for Viti labrusca cultivars. European grape growing is still in its infancy in Washington State. Through trial and error and research conducted in this state, the relative importance of climatic conditions is being realized for the Vitis vinifera cultivars.

The quality and maturation of grapes depends greatly on the accumulated heat units. Accumulated heat units is the monthly mean temperature above 50°F times the number of days per month from April 1 through October 31.

The accumulated heat units for various areas of central Washington can be seen in TM 5.

Severe winter weather will usually affect vinifera varieties more so than labrusca varieties considering management practices are similar.

Vineyards should be located in areas where adequate air drainage can take place. Free flow of air is important so that vineyards will not be located in "frost pockets." Lower elevations may be susceptible to frost pocket conditions. Frost damage may result in areas where temperatures are below 32°F and remain there because of no chance for further movement of air.

Most vineyards of Washington State are planted on south-facing slopes. Increases in sugar are due to temperature and light reception. A noticeable increase in radiation reception is seen as the percent of southern exposure increases (See Table 4).

Table 4. Percentage of Horizontal Radiation Received by Various Slopes at 45° N.

Slope	June 21	September 23
S 15°	107.0	122.5
S 10°	105.3	115.7
S 5°	103.0	108.2
level	100	100
N 5°	96.3	91.2
N 10°	91.7	81.2
N 15°	86.5	70.7

High soil fertility is necessary for most grape production. Consideration should be given to producing vinifera varieties on less fertile soil as this may decrease vigor and thus improve a grape plant's resistance to winter injury. Vinifera varieties tend to harden off in shallow sandy loam soils since dormancy is facilitated easier because nitrogen and moisture levels can be controled. Stress conditions tend to induce hardening off (See Table 5 for preferred soil and fertility for each of the grape varieties.

Table 5. Soil Texture and Fertility.

	Soil	
Type and Variety	Texture*	Fertility**
American		
Bath	SL-FSL	MF-F
Buffalo	SL-FSL	M-F
Campbell Early	SL-FSL	MF-F
Concord	LS-FLS	MF-F
Delaware	SL-FLS	MF-F
Diamond	SL-FLS	MF-F
Dutchess	LS-FLS	M-F
Eumelan	SL-FSL	MF-F
Himrod (seedless)	LS-SL	MF
Interlaken Seedless	SL-FSL	MF
Naples	LS-FSL	MF
Niagra	LS-FSL	MF-F
Romulus (seedless)	LS-FSL	M-MF

Table 5. Soil Texture and Fertility. (continued)

Type and Variety	Soil Texture*	Fertility**
Seneca	SL-FSL	MF-F
Schuyler	SL-FSL	MF-F
Van Buren	SL-FSL	MF-F
Vergennes	SL-FSL	L-MF
European		
Barbera	LS-SL	M-L
Black Monukka (seedless)	LS-FSL	MF
Cabernet Sauvignon	SL	M
Chardonnay	LS-SL	M-ML
Chauche noir	SL-FSL	M
Chauche gris	SL	M
Chenin blanc	SL-LS	M-ML
Csaba	SL-FSL	M-ML
Delight (seedless)	SL-FSL	M-F
French Columbard	SL-LS	M-ML
Gamay Beaujolais	SL-FSL	M-F
Grenache	LS-SL	L
Grey Riesling	LS-FSL	L-F
Helena	SL	MF
Melon	SL-FSL	M-F
Merlot	SL-FSL	M-F
Meunier	SL-FSL	M-F
Muller-Thurgau	SL-FSL	M-F
Muscat Hamburg	SL	ML
Muscat Ottonel	SL-FSL	M-F
Nebbiolo	LS-SL	ML
Palomino	LS-SL	M-ML
Petite Sirah	SL	M
Pinot blanc	SL-FSL	M-F
Pinot gris	SL-FSL	M-F
Minot noir	SL-FSL	M-F
Royalty	LS-SL	M-ML
Rubired	LS-SL	M-ML
Sauvignon vert	SL	M
Semillon	SL-FSL	M
Sylvaner	SL-FSL	M-MF
Thompson Seedless	LS	ML
White Riesline	SL-FSL	M-MF
Zinfandel	LS-SL	M-ML

(Courtesy WSU)

*Soil Texture: S = Sand; L = Loam; SL = Sandy Loam; LS = Loamy Sand; FSL = Fine Sandy Loam.

**Soil Fertiliey: L = Low; ML = Moderately Low; M = Medium; MF = Moderately Fertile; F = Fertile.

Soil depth and drainage is extremely important as soils with depths less than three feet restrict the growth of a grape plant's extensive root system. A medium-light textured deep soil is ideal. Soils should be non-calcareous.

Saline soil conditions can restrict a vine's ability to absorb water rapid enough to meet its requirements. Quality and yield of fruit will be directly affected by this.

Salts can accumulate in soils for a number of reasons which include:

1. Irrigation water of high salinity.
2. Salt content of the soil was originally too high.
3. Poor soil drainage.
4. Impervious soil layers can collect water at shallow depths.

European grapes are more resistant to soils with a pH over 8.

References

Ahmedullah, M. and A. I. Dow. "Soil Fertility and Nutrition Management of Washington Vineyards." Extension Bulletin 0874, Cooperative Extension, Washington State University, Pullman, Washington.

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Clore, W. J. and R. B. Tukey. "Grape Varieties for Eastern Washington." Extension Circular 394, Cooperative Extension, Washington State University, Pullman, Washington.

Klein, Joel K. "Wine Production in Washington State." Chateau Ste. Michelle, Woodinville, Washington.

Weaver, Robert J. "Grape Growing." John Wiley and Sons, New York, New York.

Name________________

Test

Site Selection for the Vineyard

1. Match

____a. Vitis vinifera	1. This helps in determining the quality and maturation of grapes.
____b. Southern slope	2. 175 frost-free days or more is preferred for this grape type.
____c. Accumulated heat units	3. Lower elevation areas may have these.
____d. Frost pockets	4. Radiation reception increases as this increases.
____e. European grape	5. Its natural vigorous growth helps it adapt to non-fertile soils.

2. Select the following statements that are correct.

____a. Stress conditions tend to favor hardening off.

____b. High soil fertility is favorable for American type grape production.

____c. Grapes prefer shallow soils with low fertility levels.

____d. Temperature and light reception help in increasing the sugar content of grapes.

____e. Vinifera varieties are more susceptible to winter injury than are labrusca varieties.

____f. American grape varieties will do well in areas of 165 frost-free days.

3. Define the following terms:

   a. Length of growing season.

   b. Accumulated heat units.

4. Describe the soil texture and fertility level that is recommended for the two grape types.

5. List the grape type that is resistant to a pH of 8 or over.

6. Describe what happens to horizontal radiation as we go from a north facing slope to a south facing slope.

7. List one item that is affected by horizontal radiation.

8. Essay - 5 pts.

   Using TM 1 + TM 5, compare the accumulated heat units and frost-free days of three selected locations. Which are more conducive to raising Vitis vinifera grapes?

Answer Sheet

Site Selection for the Vineyard

1. 2 or 5 a.

   4 b.

   1 c.

   3 d.

   2 or 5 e.

2. a, b, d, e, f.

3. a. Average number of frost-free days.

   b. The monthly mean temperature above 50°F times the number of days per month from April 1 through October 31.

4. American - Sandy loam with medium fertility.

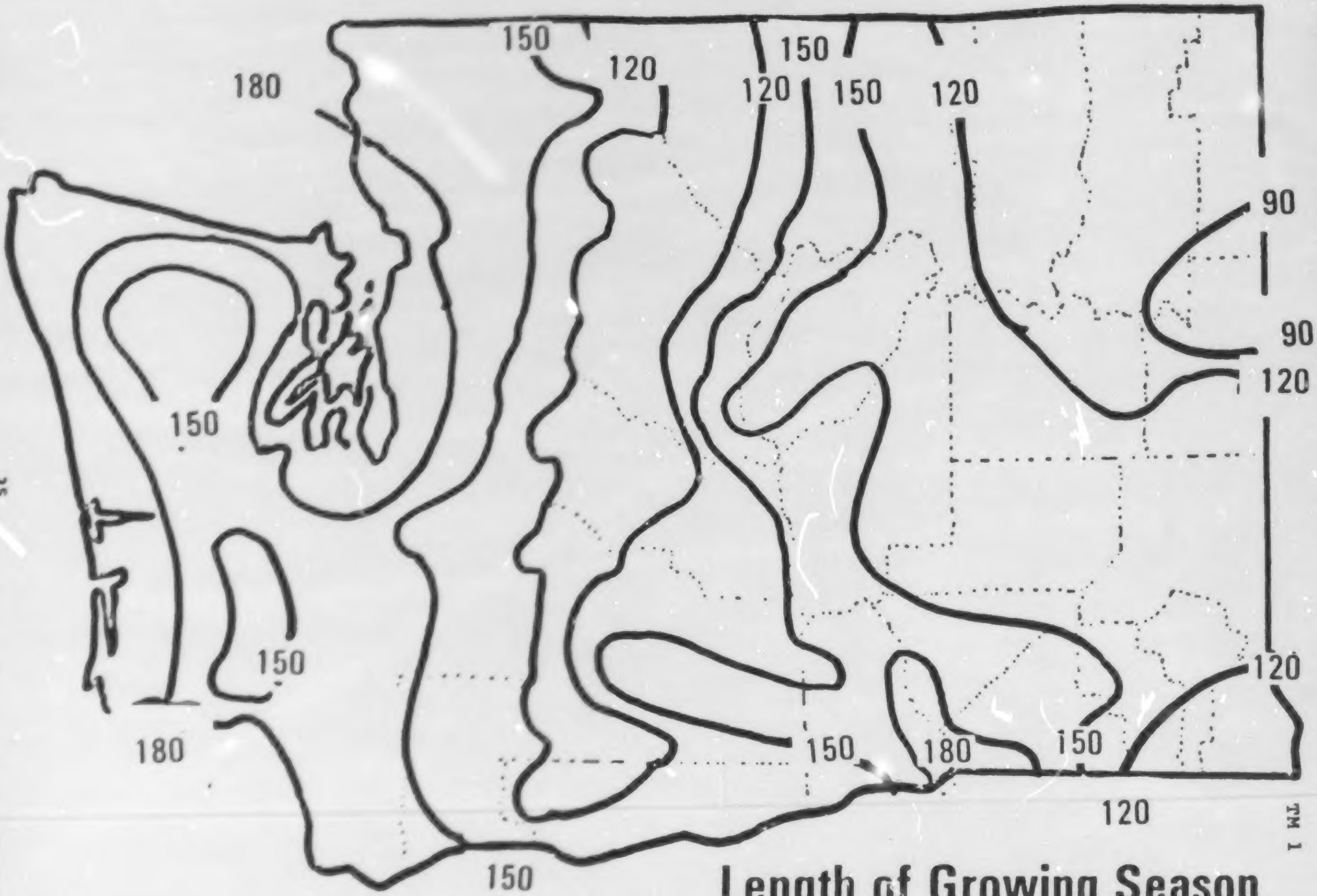
   European - Loamy sands to sandy soil with medium low fertility.

5. Europeans.

6. Horizontal radiation increases as we go from a north facing slope to a south facing slope.

7. Sugars.

8. Grade each essay on individual merits. Refer to TM 1 + TM 5.


180
150
120
150
120
150
120
150
150
90
90
120
150
120
180
150
180
150
120
150

Courtesy: Washington State University

Length of Growing Season
(Number of Frost Free Days)

Varieties for Cooler Areas--1,500 to 2,000 Degree Day Heat Units (at Least 150 Frost-Free Days)

American	European
Bath	*Csaba
Buffalo	Easly Muscat
Campbell Early	Muller-Thurgau
Diamond	Muscat Ottonel
Eumelan	Pinot noir
*Himrod (seedless)	
*Interlaken Seedless	
Seneca	
*Schuyler	
*Van Buren	

Courtesy WSU

*Earliest maturing.

Varieties for Cooler Areas--2,000 to 2,500 Degree Day Heat Units (at Least 160 Frost-Free Days)

American	European
Bath	Black Monukka (seedless)
Buffalo	Cabernet Sauvignor
Campbell Early	Chardonnay
Concord	Chauche noir
Delaware	Chauche gris
Diamond	Chenin blanc
Cutchess	*Csaba
Eumelan	Delight (seedless)
*Himrod (seedless)	Early Burgundy
*Interlaken Seedless	Early Muscat
Naples	+Gamay Beaujolais
Niagra	Gewurztraminer
Romulus (seedless)	Grenache
Seneca	Grey Riesling
*Schuyler	Helena
*Van Buren	Limberger
Vergennes	Melon
	Merlot
	+Pinot Meunier
	Muller-Thurgau
	Muscat Hamburg
	Muscat Ottonel
	Nebbiolo
	Palomino
	Petite Sirah
	Pinot blanc
	Pinot gris
	Pinot noir
	Sauvignon vert
	Semillon
	Sylvaner
	Thompson Seedless
	White Riesling

Courtesy WSU

---

*Earlier maturing.
+Pinot noir strain.

Varieties for Warmest Areas--2,500 to 3,000 Degree Day Heat Units (at Least 170 Frost-Free Days)

American	European
Concord	*Barbera
Dutchess	Black Monukka (seedless)
Eumelan	Cabernet Sauvignon
Naples	Chardonnay
Niagara	Chauche noir
Romulus	Chauche gris
Vergennes	*Chenin blanc
	Delight (seedless
	*French Colombard
	*Grenache
	Helena
	Melon
	Merlot
	Muscat Hamburg
	*Nebbiolo
	Palomino
	*Petite Sirah
	Pinot blanc
	Pinot gris
	*Royalty
	*Rubired
	*Sauvignon vert
	Semillon
	Sylvaner
	Thompson Seedless
	White Riesling
	*Zinfandel

Courtesy WSU

*Latest to ripen.

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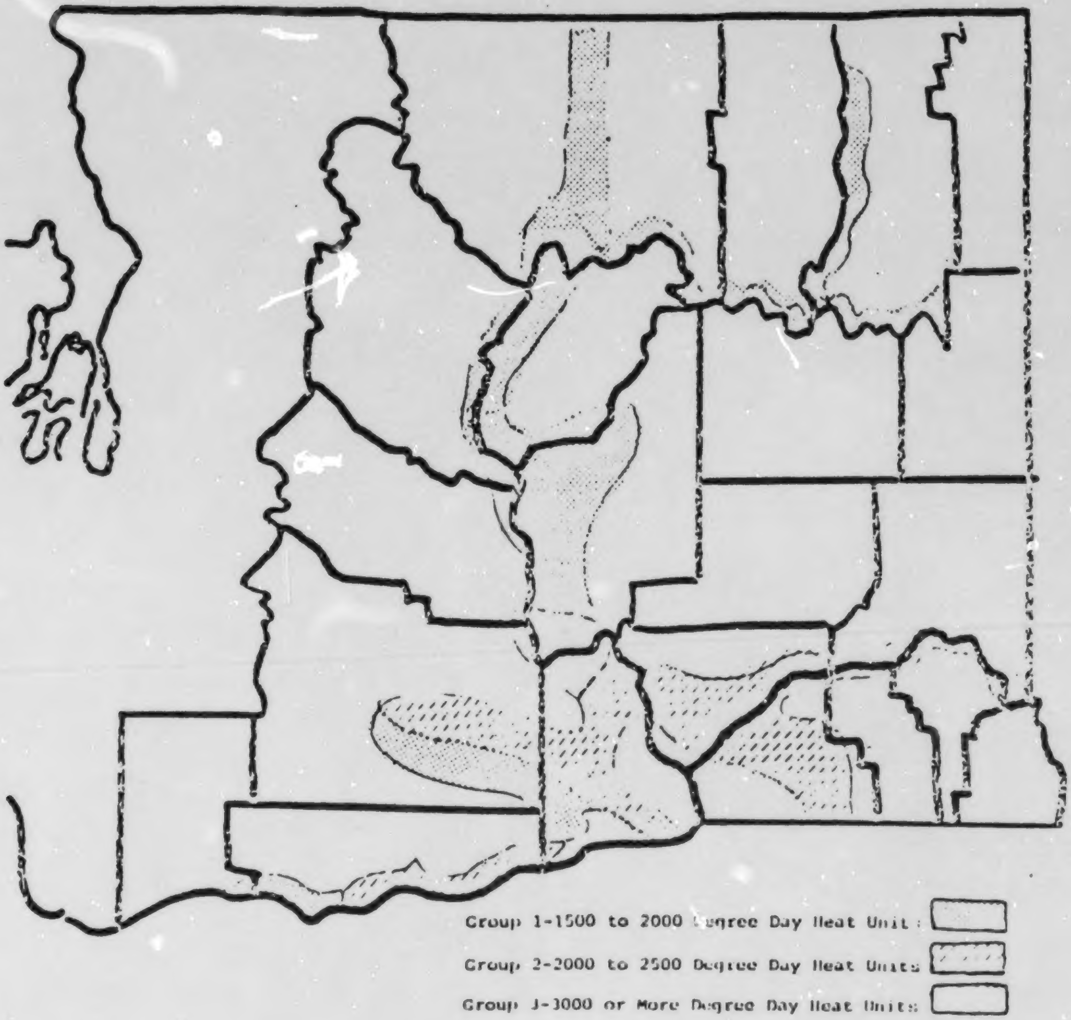
TM 5

Adaptation of Grape Varieties in Washington


Group 1-1500 to 2000 Degree Day Heat Units
Group 2-2000 to 2500 Degree Day Heat Units
Group 3-3000 or More Degree Day Heat Units

Courtesy: Washington State University

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Establishment and Production Costs

Unit V

Unit Goal: The student will develop an understanding of the costs of establishing and producing grapes.

Unit Objectives: Upon completion of the unit, the student will be able to:

1. List all establishment costs for a grape vineyard.
2. List all production costs for a grape vineyard.
3. Discuss the considerations that must be made in each annual production cost area.
4. Analyze and interpret the importance of annual production costs per acre, and operator's labor and management return per acre at selected yields and prices.

Unit Content Outline

I. Market Trends.
    A. Juice.
    B. Wine.
II. Establishment Costs.
    A. Land Preparation.
    B. Surveying and Staking.
    C. Plants.
    D. Planting.
    E. Trellising.
    F. Irrigation.
    G. Weed Control.

III. Annual Production Costs.

- A. Trellis Repair.
- B. Pruning and Tieing.
- C. Fertilizer.
- D. Cultivation.
- E. Cover Crop.
- F. Irrigation.
- G. Insect and Disease Control.
- H. Harvesting.
- I. Cash Overhead.
  - 1. Property taxes.
  - 2. Irrigation assessments.
  - 3. Interest on borrowed money.
  - 4. Labor and property insurance.
  - 5. Office costs.
- J. Investment Overhead.
  - 1. Depreciation on buildings, equipment, and land.
  - 2. Interest on the investment.

IV. Interpretation of Production Costs.

V. Supply and Demand.

- A. Wine Grapes.
- B. Concord Grapes.

Suggested Activities:

- Review a project record book of a student that is managing, renting, or buying a grape vineyard. Have the students list the establishment costs and annual production costs.
- Have guest lecturer from your local bank or production credit association.

Information Sheet

Vineyard Establishment and Management Establishment Production Cost for European and American Grapes

Most grapes in Washington were marketed for processing into juice or wine. Due to the expense of establishing a vineyard, a farmer should thoroughly be aware of present and future market situations before they plant a vineyard.

Plantings of European varieties of grapes have increased at a faster rate than any other type of grape in Washington.

Initial costs of establishment for European type grapes are similar to those for American type grapes. Initial land costs for wine grapes may be higher than land costs are for American type grapes. Available land that is both irrigable and frost free is limited thus putting a premium on the cost of the land.

Establishment costs include costs for land preparation, surveying and staking, plants, planting, trellising, irrigation, and weed control.

Annual production costs include the following:

1. Trellis repair.
2. Pruning and tying.
3. Fertilizer.
4. Cultivation.
5. Cover crop.
6. Irrigation.
7. Insect and disease control.
8. Harvesting.
9. Cash overhead.
10. Investment overhead.

Trellis repair costs may vary considerably from one vineyard to another. Repairs vary due to the type of trellis, age of the vineyard, spacing of line posts, and the method of harvesting.

Pruning and tying vary considerably also. Experience of the workers, the weather at pruning time, and the type of training affect the total cost.

Fertilizer costs are naturally going to be affected by vine vigor and the age of the vines. Nitrogen is commonly used on Concord vineyards. Fertilizer costs will vary depending upon soil fertility.

Weed control methods takes place early in the growing season. Other costs may include a grain-vetch cover crop during mid-summer.

Irrigation costs vary according to the number of irrigations used during the growing season. Annual irrigation district assessments must also be included in these costs.

Insect and disease problems vary greatly from one year to the next. Costs usually include a dormant spray and possibly sulfur for mildew control.

Harvesting costs include the method of harvesting used (mechanical or hand) and hauling costs which is determined by the method of hauling and the distance of the haul to the processing plant.

Cash overhead costs include property taxes, irrigation assessments, interest on the money needed as operating capital, and utilities. Other charges are labor and property insurance and office costs.

Investment overhead includes depreciation on equipment, buildings, and land. It also includes interest on the investment.

All the previous areas addressed to include labor, machinery, fuel, and materials costs. The total of the areas discussed gives the farmer his total annual costs per acre. (See TM 6 and 7.)

To avoid problems in interpreting the following tables, the reader must refer to Extension Bulletins EB 0875 and Extension Bulletin entitled "Establishment and Production Costs for Wine Grape Vineyards, 1983." The user must consider the assumptions made by the extension economist when the tables were established. The assumptions may or may not fit into your situations. If they do not, other adjustments may be made.

Monthly cash outflow per acre is important to farmers when money must be borrowed. This gives a good indication of monthly production costs.

Another valuable management tool for a vineyard operator is his knowledge of his percent return per acre or profit level at various yields and prices. For example, at $650 per ton with a yield of 5 tons per acre, a vineyard owner with wine grapes would have a return of 29.52 percent based on 1981 figures. (TM 8 and TM 9)

Since 1978, the number of wineries in Washington State has increased from six to forty.

The youthful Washington wine industry faces a problem of marketing. Many more acres of grapes will begin producing next year. The industry will have to find new markets outside of the state of Washington in the future.

Until this is done, the basic laws of supply and demand will begin to dictate the wine grape industry in the future as it is currently doing with concord grapes used for juice.

Considerations must also be given to capital, commodity prices, crop yields, growing practices, machinery, labor resources, input prices, and enterprise size as these may vary from farm to farm thus affecting the vineyard owner's costs and returns.

References

Folwell, R. J. and D. J. Kirpes. "Establishment and Production Costs, Concord Grape Vineyards, 1982." Extension Bulletin 0875, Cooperative Extension, Washington State University, Pullman, Washington.

Folwell, R. J. and D. J. Kirpes. "Establishment and Production Costs for Wine Grape Vineyards, 1983." Proposed Extension Bulletin, Cooperative Extension, Washington State University, Pullman, Washington.

Name______________________

Test

Establishment and Production Costs for Grapes

1. Match as either an establishment cost or an annual production cost.

   a. Establishment cost.

   b. Annual production cost.

   c. Both a and b.

   ____1. Trellis Repair
   ____2. Investment Overhead
   ____3. Cash Overhead
   ____4. Pruning and Tying
   ____5. Irrigation
   ____6. Harvesting
   ____7. Weed Control
   ____8. Land Preparation
   ____9. Cover Crop
   ___10. Insect and Disease Control
   ___11. Surveying and Staking
   ___12. Fertilizer
   ___13. Planting and Trellising
   ___14. Plants
   ___15. Cultivation

2. Essay:

   Using all annual production costs, explain the considerations or management decisions that must be made in each of the production cost areas.

3. Compare the supply and demand situation for concord grapes versus wine grapes. How is this presently affecting the price received by grape farmers?

4. Using TM 5, complete the labor and management return per acre at the following yields and prices.

   a. $350/ton at a yield of 7 ton/acre

      Answer: ______

   b. $650/ton at a yield of 4 ton/acre

      Answer: ______

   c. $800/ton at a yield of 7 ton/acre

      Answer: ______

   d. $600/ton at a yield of 5 ton/acre

      Answer: ______

   e. $700/ton at a yield of 6 ton/acre

      Answer: ______

   f. Which price and yield gives the operator the greatest return per acre?

Answer Sheet

Establishment and Production Costs for European and American Type Grapes

1. 1. b
   2. b
   3. b
   4. b
   5. a and b
   6. b
   7. a
   8. a
   9. b
   10. b
   11. a
   12. b
   13. a
   14. a
   15. b

2. Areas of consideration include trellis repair, pruning, tying, fertilizer, cultivation, cover crop, irrigation, insect control, disease control, harvesting, cash overhead, and investment overhead.

   Type of trellis, age of the vineyard, and the method of harvesting are all considerations in trellis repair costs.

   The costs of pruning and tying will vary with the experience of the workers, type of training, and the weather at pruning time.

   The type of grape and soil fertility help determine fertilizer costs.

   Weed control may vary only slightly from year to year. A cover crop in mid-summer is often used as a weed control method.

Irrigation costs are going to vary according to irrigation assessment costs and the number of irrigation assessment costs and the number of irrigations used during the growing season.

Insect and disease problems will vary greatly from year to year due to environmental conditions.

The method of harvesting used and the distance of the haul will determine harvesting costs.

Property taxes, irrigation assessments, labor, property insurance, and interest are considerations that must be included in cash overhead.

Investment overhead includes depreciation on equipment, buildings, and land.

3. Currently, there is an oversupply of grape juice in the United States which is suppressing Concord grape prices. On the other hand, demand has been steady for wine grapes. This is reflected by the increaes in the number of wineries in Washington State.

   Two conditions could change the wine grape market. Thousands of acres will come into production within the next few years and whether Washington wineries will increase their marketing potential.

4. a. 14%

   b. 19.7%

   c. 66.5%

   d. 25.4%

   e. 44.3%

   f. $800/ton at a yield of 7 ton/acre

TM 6. Total Cost and Average per Acres Cost per Concord Grape Vineyard Size in Washington, 1982.[1]

				Vineyard Size			
	5 Acres	25 Acres	50 Acres	100 Acres	200 Acres	300 Acres	500 Acres
	$	$	$	$	$	$	$
Variable Cost							
Mach. & Trac. Repairs & Fuel	437.47	2,187.38	4,374.77	8,641.08	17,322.19	26,026.91	44,626.97
All Other Var. Costs	3,671.90	18,359.50	36,719.00	73,438.00	146,876.00	220,314.00	367,190.00
Fixed Cost							
Machinery & Tractors	814.83	3,408.19	6,649.89	10,254.77	18,264.95	26,275.09	37,502.20
Irrigation Machinery	879.00	4,395.00	8,790.00	17,580.00	35,160.00	52,740.00	87,900.00
Real Estate Taxes	286.95	1,434.75	2,869.50	5,739.00	11,478.00	17,217.00	28,695.00
Amort. Est. Cost[2]	4,437.20	22,186.00	54,954.50	109,909.00	219,818.00	329,727.00	549,545.00
Net Land Rent	550.00	2,750.00	5,500.00	11,000.00	22,000.00	33,000.00	55,000.00
Total Cost	$11,072.60	$54,711.26	$119,857.66	$236,561.85	$470,919.14	$705,300.00	$1,170,459.17
Average Cost per Acre	$2,214.52	$2,188.45	$2,397.15	$2,365.62	$2,354.60	$2,351.00	$2,340.92

(Courtesy: WSU)

[1] Assuming an Average yield of 8 tons per acre.

[2] Assuming an average amortized establishment cost of $887.44 per acre.

TM 6

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TM 7. Total Cost and Average per Acre Cost per Wine Grape Vineyard in Washington, 1983.[1]

					Vineyard Size			
	25 Acres	50 Acres	75 Acres	100 Acres	200 Acres	300 Acres	400 Acres	500 Acres
	$	$	$	$	$	$	$	$
Variable Cost								
Mach. & Trac. Repairs & Fuel	1,363.57	2,627.86	4,158.28	5,734.74	14,680.67	22,905.50	30,779.79	38,468.08
All Other Var. Costs	24,243.70	48,487.40	72,731.10	96,974.80	123,969.60	185,954.40	247,939.20	309,924.00
Fixed Cost								
Machinery & Tractors	7,339.76	9,940.33	10,220.91	10,997.18	47,904.39	52,400.95	86,186.41	95,827.48
Irrigation Machinery	4,450.75	8,901.50	13,352.25	17,803.00	35,606.00	53,409.00	71,212.00	89,015.00
Real Estate Taxes	1,440.00	2,880.00	4,320.00	5,760.00	11,520.00	17,280.00	23,040.00	28,800.00
Amort. Est. Cost[2]	14,877.50	29,755.00	44,632.50	59,510.00	119,020.00	178,530.00	238,040.00	297,550.00
Net Land Rent	2,750.00	5,500.00	8,250.00	11,000.00	22,000.00	33,000.00	44,000.00	55,000.00
Total Cost	56,465.28	108,092.09	157,665.04	207,779.72	374,700.66	543,479.85	741,197.40	914,584.56
Average Cost	2,258.61	2,161.84	2,102.20	2,077.80	1,873.50	1,811.60	1,852.99	1,829.17

(Courtesy: WSU)

[1] Assuming an average yield of 5.44 tons per acre.

[2] Assuming an average amortization cost of $595.10 per acre.

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TM 8. Rate of Return (%) to Land ($6,000 per acre) and Management for a 50-Acre Wine Grape Vineyard in Washington, 1981.

Yield Tons/Acre	Price per Ton $350	$400	$450	$500	$550	$600	$650	$700	$750	$800	$850
1	-14.48	-13.65	-12.81	-11.98	-11.15	-10.31	- 9.48	-8.65	- 7.81	- 6.98	- 6.15
2	- 9.73	- 8.06	- 6.40	- 4.73	- 3.06	- 1.40	0.27	1.94	3.60	5.27	6.94
3	- 4.98	- 2.48	0.02	2.52	5.02	7.52	10.02	12.52	15.02	17.52	20.02
4	- 0.23	3.10	6.44	9.77	13.10	16.44	19.77	23.10	26.44	29.77	33.10
5	4.52	8.69	12.85	17.02	21.19	25.35	29.52	33.69	37.85	42.02	46.19
6	9.27	14.27	19.27	24.27	29.27	34.27	39.27	44.27	49.27	54.27	59.27
7	14.02	19.85	25.69	31.52	37.35	43.19	49.02	54.85	60.69	66.52	72.35
8	18.77	25.44	32.10	38.77	45.44	52.10	58.77	65.44	72.10	78.77	85.44
9	23.52	31.02	38.52	46.02	53.52	61.02	68.52	76.02	83.52	91.02	98.52
10	28.27	36.60	44.94	53.27	61.60	69.94	78.27	86.60	94.94	103.27	111.60

(Courtesy: WSU)

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TM 9. Profit Level ($/Acre) Given Varying Yields and Prices for the 25-Acre Concord Grape Vineyard in Washington, 1982.

Yield Tons/Acre	Price per Ton									
	$130	$135	$140	$145	$150	$155	$160	$165	$170	$175
4	-1,545.29	-1,525.29	-1,505.29	-1,485.29	-1,465.29	-1,445.29	-1,425.29	-1,405.29	-1,385.29	-1,365.29
5	-1,445.39	-1,420.39	-1,395.39	-1,370.39	1,354.39	-1,320.39	-1,295.39	-1,270.39	-1,245.39	-1,220.39
6	-1,345.49	-1,315.49	-1,285.49	-1,255.49	-1,225.49	-1,195.49	-1,165.49	-1,135.49	-1,105.49	-1,075.49
7	-1,245.59	-1,210.59	-1,175.59	-1,140.59	-1,105.59	-1,070.59	-1,035.59	-1,000.59	- 965.59	- 930.59
8	-1,145.[illegible]	-1,105.69	-1,065.69	-1,025.69	- 985.69	- 945.69	- 905.69	- 865.69	- 825.69	- 785.69
9	1,045.79	-1,000.79	- 955.79	- 910.79	- 865.79	- 820.79	- 775.79	- 730.79	- 685.79	- 640.79
10	- 945.89	- 895.89	- 845.89	- 795.89	- 745.89	- 695.89	- 645.89	- 595.89	- 545.89	- 495.89
11	- 845.99	- 790.99	- 735.99	- 680.99	- 625.99	- 570.99	- 515.99	- 460.99	- 405.99	- 350.99
12	- 746.09	- 686.09	- 626.09	- 566.09	- 506.09	- 446.09	- 386.09	- 326.09	- 266.09	- 206.09
13	- 646.19	- 581.19	- 451.19	- 516.19	- 451.19	- 321.19	- 256.19	- 191.19	- 126.19	- 61.19

(Courtesy: WSU)

Footnote: Preharvest variable cost = $581.12 per acre.
Harvest variable cost = $30.10 per ton.
Total fixed cost = $1,363.77 per acre.

TM 9

BEST COPY AVAILABLE

Propagation, Nursery Stock, Soil Preparation, and Planting

Unit VI

Unit Goal: The student will become familiar with propagation methods, nursery stock, soil preparation methods and planting procedures for grapes.

Unit Objectives: Upon completion of the unit, the student will be able to:

1. Identify and select plant material to be used for grape cuttings.
2. Describe the correct way to make a grape cutting and bury them for rooting.
3. List the processes of planting and caring for plants in the nursery.

Unit Content Outline

Propagation, Nursery Stock, Soil Preparation and Planting

I. Propagating.
    A. Materials.
        1. Sources.
        2. Type of wood.
        3. Time of year.
        4. Correct method of taking cuttings.
    B. Burying.

II. Nursery Stock.

III. Soil Preparation and Planting in the Nursery.
    A. Shanking.
    B. Spacing.

    C. Planting.
    D. Hilling.
    E. Digging.
- IV. Planting.
    A. Spacing.
        1. Reasons.
        2. Distance.
    B. Number of Plants per acre.

Suggested Activities:

--Propagate grape cuttings in class.

--Establish a grape nursery and vineyard on the school farm.

--Layer grape plants in established vineyards.

Information Sheet

Propagation, Nursery Stock, Soil Preparation, and Planting

There are two grape types important to commercial production in Washington. They are European and American type grapes.

Propagating material may be secured from another grower or from a grower's own vineyard. The best source of nursery stock material is from nurseries that produce plants that are certified to variety and free from known virus diseases.

Grape cuttings should be taken from dormant wood late in the fall. Cuttings taken any later may have freeze damage to the buds. Canes should be pencil size in thickness and have 3 to 4 buds. The basal cut should be 1/4 inch below the lowest bud, the upper cut should be a slanted cut to help identify the top end of the cutting.

Cuttings should then be bundled in groups of 25 with the basal end cuts together. Bundles should then be buried in a pit of 1 1/2 ft. to 2 ft. deep with the basal ends up. The bundles should be buried with 4 inches of moist light soil or sand over the top. Straw may be used to cover the soil. As the straw decomposes, heat is given off which stimulates root development. Black plastic is used to prevent moisture loss and increase soil temperature when the plastic is exposed to the sun.

During the month of April, callusing should start. When most plants have callused they are ready to be planted in the nursery.

Cuttings should be planted 4 inches apart in rows. The cuttings should be place basal end down in furrows or shanked rows with the top-most bud just above soil level.

Irrigation of the cuttings should immediately follow. Sprinkler irrigation will insure good soil contact around each cutting. Soil should be hilled around the top bud to prevent drying out in windy areas.

Plants should be maturing during the late summer. Hardiness can be induced by restricting or removing water in August.

Plants dug in the fall can be bundled and placed in sawdust, sand, or medium moist soil. Survival increases if the vines are left in the nursery through the winter.

The distance between rows and plants is a major concern when establishing a vineyard. Two items are of major concern when developing row spacing. Rows should be planted close enough to utilize the land efficiently and wide enough to facilitate movement of equipment. Vine vigor and the type of trellis used should also be considerations.

Distance between plants depends greatly upon the plants growth habit and the soils fertility. A distance of six feet to eight feet is common for American type grapes while European grape types are normally spaced eight feet. Refer to Table 6 for planting distances and the number of plants per acre.

Table 6. Planting Distance and Number of Plants per Acre.

Planting Distance	Number of Plants per Acre
6 x 9	807
7 x 9	691
8 x 9	605
6 x 10	726
7 x 10	622
8 x 10	545
9 x 10	484
6 x 11	660
7 x 11	566
8 x 11	495
9 x 11	440
10 x 11	396

(Courtesy WSU)

Layering which is done during dormancy, can be used to replace missing plants in a vineyard. Often, plants from a nursery cannot compete with established plants so a vigorous cane from a vine next to a missing plant will be buried in a trench 12" deep with the tip of the cane protruding above the soil surface. The apical end of the cane should be in the correct location to replace the missing plant and pruned back to two buds.

All new growth, with the exception of one shoot for the main trunk, should be removed. After the third year of development, the new plant can be cut from the parent plant.

References

Childers, Norman F. "Modern Fruit Science." Horticulture Publications, New Brunswick, New Jersey.

Clore, W. J. "Propagating Grapes from Cuttings." Cooperative Extension, Washington State University, Pullman, Washington.

Weaver, Robert J. "Grape Growing." John Wiley and Sons, New York, New York.

Name____________________

Test

Propagation, Nursery Stock, Soil Preparation, and Planting

1. Match:

____1. Certified Stock

____2. Callusing

____3. Straight Cut

____4. Angle Cut

____5. Black Plastic

____6. Straw

a. The cut made when taking a grape cutting on the basal end.

b. The cut made when taking a grape cutting on the top end.

c. Used to cover the pit that contains buried cuttings.

d. Plants that are true to variety and free from known diseases.

e. Healing of grape cutting on basal end.

f. Decomposition of this produces heat.

2. Select the following statements which are correct:

____1. Canes for cuttings should be from wood 1/2" in diameter.

____2. Black plastic is used to prevent moisture loss in the pits that are used to bury the cuttings.

____3. Grape cuttings should be taken before the plants go into dormancy.

____4. After planting in the nursery row, soil should be hilled around the top bud to prevent drying out.

____5. Hardiness of the young grape plant can be induced by removing water in August.

____6. Layering should be done during the growing season.

____7. The plant resulting from layering should be removed from the parent plant after the first year of growth.

Answer Sheet

Propagation, Nursery Stock, Soil Preparation, and Planting

1.
   - d 1.
   - e 2.
   - a 3.
   - b 4.
   - c 5.
   - d 6.

2. 2, 4, 5.

3. 1. True to variety.
   2. Free from known virus disease.

4. Row spacing distance: a. close to utilize land
   b. far enough to facilitate equipment

   Plant spacing distance: a. plants growth habit
   b. soil fertility

5. a. Grape cuttings should be taken from dormant wood. The canes should be pencil size in thickness and have 3-4 buds. The basal cut should be straight and the top cut slanted to prevent confusion when burying the cuttings. The basal ends of the cuttings should be placed up in a pit 1 1/2' - 2' deep and then covered with straw and black plastic.

   b. Layering is also done when the plant is dormant. A vigorous vine is used from a parent plant and buried in a trench 12" deep with the tip of the vine protruding out. This vine is girdled between the parent plant and the tip of the vine to help stimulate root growth. The plant is then detached from the parent plant after three years. One strong shoot be maintained and the others removed after the first year of growth.

Fertilization and Nutritional Disorders

Unit VII

Unit Goal: The student will understand the fertilization requirements and nutritional disorders that are associated with grapes.

Unit Objectives: Upon completion of the unit, the student will be able to:

1. Recognize the soil test values for different nutrients and determine the recommendation by using the tables found in the unit.
2. Determine what conditions prevail when there is a nutritional deficiency.
3. State the physical characteristics of a grape plant that has a nutritional disorder.

Unit Content Outline

Fertilization and Nutritional Disorders

I. Soil Testing.

  A. Soil Values.

    1. Phosphorus (P)
    2. Potassium (K)
    3. Boron (B)
    4. Zinc (Zn)
    5. Nitrogen (N)
    6. Sulfur (S)

B. Fertilizer Recommendations.

1. Nitrogen.
    a. table.
2. Phosphorus.
    a. cover crops.
    b. table.
3. Potassium.
    a. table.
4. Zinc.
    a. foliage spray.
    b. 20-30 lbs. per acre if deficient.
5. Sulfur.
    a. irrigation water.
    b. 20-30 lbs. per acre if deficient.
6. Iron.
    a. water.
    b. foliage spray.
7. a. dry winter.
    b. 3 lbs. per acre if deficient.

II. Nutritional Deficiency.

A. Essential Elements.

1. Macronutrients.
2. Micronutrients.

B. Deficiencies.

1. Nitrogen.
2. Potassium.
3. Zinc.
4. Iron.
5. Boron.

Suggested Activities:

--Take soil tests of school farm. Compare soil values to tables in the unit.

--Show vineyards or plant samples of grape plants with nutritional disorders.

Information Sheet

Fertilization

During soil preparation it is very important that one is aware of the fertility of the soil. Soil testing can be done by sampling different areas within the vineyard. Soil values should be kept above the following standards as seen in Table 7.

Table 7. Soil Values Needed in Vineyards.

Phosphorus (P)	10 ppm
Potassium (K)	24 ppm
Boron (B)	0.5 ppm
Zinc (Zn)	0.8 ppm

(Courtesy WSU)

Soil test for nitrogen (N) or sulfur (S) are not always useful in grape production. Soil tests do not always show what is available for plant use.

Before planting the new vineyard the following recommendation for nitrogen should be followed as seen in Table 8.

Table 8. Nitrogen To Be Applied To New Vineyards Before Planting.

If Previous Cropping was	Apply This Amount (Lbs.per Acre) American (Concord Campbell Early, etc.)	European Vinifers)
New land	160	80
Corn or small grain residue removed	120	60
Corn or small grain straw to be plowed under	140	70
Potatoes or sugar beets	100	50
Beans of peas	100	50
Alfalfa, no top growth	100	50
Alfalfa, considerable top growth to be plowed under	60	30

(Courtesy WSU)

Phosphorus is usually applied to vineyards primarily to aid the cover crop. Grapes have not responded to applications of phosphorus in Washington State.

Refer to Table 9 for application rates for P_2O_5.

Table 9. Application Rates for P_2O_5.

If Soil Test Reads ppm	Apply This Amount of P_2O_5 In Lbs. per Acre
2	295
4	204
6	159
8	114
10	68
Above 10	0

Courtesy WSU

Refer to Table 10 for application rates for Potassium.

Table 10. Application Rates for Potassium.

If Soil Test Reads ppm	Apply This Amount of K_2O In Lbs. per Acre
60	480
120	360
180	240
204	120
	0

Courtesy WSU

In vineyards where the soil test for Zn is less than .8 ppm, 20 to 30 lbs. per acre should be added before planting. If zinc deficiency is visible, a foliage spray can be used.

Sulfur may have to be added if the irrigation water is low in sulfur. If this is the case, S fertilizer should be added at a rate of 40 lbs. per acre.

Iron deficiency may be found in soils with high water tables, high lime soils or soils of poor drainage. Chlorosis of vines can be overcome by using a foliage spray.

Boron deficiency may also be found in soils after a dry winter. If the soil test reads less than .5 ppm, apply 3 pounds per acre of boron.

All preplant fertilizer should be plowed under at least one foot.

Good water management is important to the nutrition of crops. Drought conditions directly relate to boron deficiency and excess water conditions can cause iron chlorosis.

Another method of assessing plant nutrient needs is by taking vine tissue analysis. This is a good indication of plant nutrient use and need.

Information Sheet

Nutritional Disorders

Sixteen elements are essential to all plant growth: Carbon, hydrogen. and oxygen are obtained from water and the air.

The other thirteen elements are classified as either macronutrients or micronutrients. Table 11 classifies the macro- and micronutrients showing those that may be a deficiency problem in Washington State.

Table 11. Macro and Micro Nutrients and Possible Deficiencies in Washington Vineyards.

	Macronutrients	Micronutrients
Possible Deficiencies	Nitrogen Potassium	Zinc Iron Boron
Others	Phosphorus Calcium Magnesium Sulfur	Manganese Copper Molybdenum Chlorine

Nitrogen is often found deficient in shallow or sandy soils. A uniform light green color on the leaves is the foliar symptom. The deficiency is noticed first on the tip of the leaf and then progresses toward the base. Often yields may be reduced before deficiency symptoms appear.

Marginal chlorosis followed by intervenial chlorosis with the leaf margins becoming necrotic are the symptoms of potassium deficiency. The symptoms usually occur in mid-summer. Another potassium deficiency is is known as "blackleaf." The deficiency is associated with low K within the plant and does not necessarily mean a soil deficiency. Leaves become blackened.
The symptoms usually start on the upper exposed leaves.

Zinc deficiency is characterized by the stunting of canes. The veins are usually darker green giving way to a chlorotic pattern. Leaves are normally flattened at the base. The flowers may often shatter and the berries that set will remain green and fail to ripen.

Iron chlorosis symptoms occur on new vine growth. It is caused by a lack of mobile iron in the plant. Symptoms include yellow leaves with a new work of green veins. If symptoms are noticed early in the season, the leaves will be bright yellow by mid-summer and brown by September.

Boron deficiency can be classified into two types: 1) Early Season; and 2) Late Season. With early season deficiency shoot growth may be delayed and often the growing point may die causing buds in the leaf axis to develop causing a zig-zag appearance. The basal buds may be small showing signs of chlorosis. A resultant poor set of berries may take place.

When late season deficiency occurs, the leaves may appear to be burned. Clusters may have an inconsistent berry set with the berries ripening abnormally.

References

Ahmedullah, M. and A. I. Dow. "Soil Fertility and Nutrition Management of Washington Vineyards." EB 0874, Cooperative Extension, Washington State University, Pullman, Washington.

Ahmedullah, M., W. W. Cone, A. I. Dow, D. F. Mayer, G. Mink, R. Parker, and C. B. Scotland. "Soil Fertility and Nutrition Management of Washington Vineyards." EB 0722, Cooperative Extension, Washington State University, Pullman, Washington.

Clore, W. J., A. I. Dow, A. R. Halvorson, and R. B. Tukey. "Fertilizer Guide; Irrigated Vineyards." FG-13, Cooperative Extension, Washington State University, Pullman, Washington.

Name____________________

Test

Fertilization and Nutritional Disorders

1. Match.

a. Symbols.

____1.	Nitrogen	a.	P
____2.	Sulfur	b.	K
____3.	Zinc	c.	Zn
____4.	Potassium	d.	B
____5.	Boron	e.	N
____6.	Phosphorus	f.	S

b. Statements.

____1. Nitrogen

____2. Iron deficiency

____3. Phosphorus

____4. Zinc

____5. Boron

a. Found in soils with high water tables, high lime soils, or soils of poor drainage.

b. Used primarily as an aid to the cover crop.

c. A foliage spray is often used when this nutrient is deficient.

d. Soil tests for this nutrient may not always be useful in grape production.

e. This deficiency may be found in soils after a dry winter.

2. Select the following statements which are correct:

____a. Soil tests for Nitrogen and Sulfur are not always important in grape production.

____b. When soil testing, only one random sample is necessary to give accurate test results.

____c. Iron chlorosis can be overcome by using a foliage spray.

____d. Drought conditions may relate to boron deficiencies.

____e. Sixteen elements are essential to all plant growth.

____f. Carbon, hydrogen, and nitrogen are obtained from the water and air.

____g. A uniform light green color on the leaves is the foliar symptom of nitrogen deficiency.

____h. Boron deficiency can be both early season and late season.

____i. Macronutrients include nitrogen, potassium, phosphorus, calcium, magnesium, and sulfur.

____j. There are 7 micronutrients.

3. Describe the deficiency symptoms of:

    a. Nitrogen.

    b. Potassium.

    c. Zinc.

    d. Iron.

    e. Boron.

4. State the conditions that bring about a deficiency for:

    a. Iron.

    b. Boron.

Answer Sheet

Fertilization and Nutritional Disorders

1.

a.		b.	
e	1.	d	1.
f	2.	a	2.
c	3.	b	3.
b	4.	c	4.
d	5.	e	5.

2. a, c, d, e, g, h, i, j.

3. a. --leaves turn a light green color.
b. --deficiency noticed first on the tip of the leaf.

b. --marginal chlorosis followed by intervenial chlorosis.
--leaf margins become necrotic.

c. --stunting of canes.
--veins are usually darker green.
--leaves flattened at the base.
--berries remain green and fail to ripen.

d. --yellow leaves with green veins.
--brown leaves in September.

e. --Early Season--shoot growth delayed.
--growing point may die.
--buds will be in zig-zag position.
--poor set of berries.

--Late Season--leaves appeared burned.
--inconsistent berry set.
--berries ripen abnormally.

4. a. Lack of mobile iron in the plant.

b. Found in soils after a dry winter.

Critical Temperature and Frost Control

Unit VIII

Unit Goal: The student will develop an understanding of the critical temperature and methods of frost control for concord and European type grapes.

Unit Objectives: Upon completion of the unit the student will be able to:

1. Analyze critical temperature charts to determine the critical temperatures at various stages of bud development.
2. List management and cultural practices that may change the weather to enhance protection of grape plants against frost.

Unit Content Outline

I. Critical Temperature.
    A. Affect on yield.
    B. T_{10} - Concords.
    C. T_{90} - Concords.
    D. European varieties.

II. Frost Control.
    A. Cultural practices.
        1. Vineyard location.
        2. Soil surface conditions.
    B. Management practices.
        1. Overhead sprinklers.
        2. Wind machines.
        3. Orchard heaters.

Suggested Activities:

--Record nighttime lows in the spring. Determine T_{10} and T_{90} days for concords using this data.

--Analyze local vineyards or site locations for freedom from frost damage.

--Have the students make lists of vineyards using the various methods of frost control.

Information Sheet

Critical Temperature and Frost Control

The loss of primary buds can have an affect upon the yield of the grape crop. As buds swell, open, and begin to grow, potential frost damage increases. Critical temperature refers to those temperatures that have a potential to decrease grape yield.

Vineyards also have some buds that are more susceptible or resistant to low temperatures than others. The term T_{10} refers to temperatures likely to kill 10 percent of the primary buds. T_{90} refers to temperatures which are estimated to kill 90 percent of the primary buds. Table 12 gives the critical temperatures for concord grapes.

Table 12. Critical Temperatures for Concord Grapes.

Stage of Development	Definition	T_{10}	T_{90}
Dormant	Closed bud, inactive	variable	subzero
First swell	Buds increase in size, scales separate to show brown, fuzzy, young leaf tissues	13	-3
Full swell	Bud swells further, young leaves become pink. Still closed around growing point.	21	10
Bud burst	Young leaves separate at tip to show the growing point	25	16
1st leaf	First leaf is out of the bud, makes right angle with stem	27	21
2nd leaf	2nd leaf makes right with stem	28	22
3rd leaf		28	26
4th leaf		28	27
5th leaf		28	27

Courtesy WSU

*Critical temperatures for 10 percent (T_{10}) and 90 percent (T_{90}) kill of primary buds.

Critical temperatures for vinifera cultivars vary considerably from one variety to the next. It must be remembered that vinifera cultivars are not as frost resistant as concords.

Many cultural and management practices are available that may reduce a vineyard's susceptability to frost damage.

Selecting a vineyard location may be the most important decision that is made in relation to frost control. The vineyard should be placed where there is adequate air drainage. Try to avoid planting grapes in a frost pocket. Cold air drainage draws warm air down to the soil surface. Any brush or buildings that prevent air flow should be removed if economically feasible.

Soil surface conditions can also affect the vines susceptability to cold damage. Cover crops and trash prevent the soil from absorbing and releasing heat readily. A bare, moist soil gives the greatest amount of protection from frost.

Management can modify temperatures by using overhead sprinklers, wind machines and heaters individually or in combination with each other for frost control.

As water freezes, heat is given off. This heat maintains the temperatures on the vine parts covered by the water/ice mixture at or around 32°F. To prevent damage due to freezing, the sprinklers must be constantly running.

Wind machines are used to overcome frosts that are caused by nighttime conditions called inversions. At night, the soil loses heat from the soil surface to the sky. The air located at ground level is cooled; thus, the cool, heavier air remains at ground level with the warmer air above. The purpose of the wind machine is to mix the upper warm air with the cooler air.

Orchard heaters can be used for frost protection. The heaters give both radiant and convective heat. Radiant heat goes directly to the vines while convective heat rises out of the vineyard. If there is a strong inversion layer, the warm air will not rise as high thus benefiting the grape plants. Wind machines and orchard heaters can be used in combination with one another.

The use of orchard heaters may not be economically feasible because of oil prices. This method is currently not practiced in Washington.

References

Brummund, V. P, W. J. Clore, and E. L. Proebsting. "Critical Temperatures for Concord Grapes." EM 4330, Cooperative Extension, Washington State University, Pullman, Washington.

Childers, Norman F. "Modern Fruit Science." Horticultural Publications, Rutgers University, New Brunswick, New Jersey.

Weaver, Robert J. "Grape Growing." John Wiley and Sons, New York, New York.

Name____________________

Test

Critical Temperature and Frost Control

1. Match:

____a. T_{10}

____b. Convective heat

____c. T_{90}

____d. Critical temperature

____e. Radiant heat

____f. Heat

1. Refers to temperatures likely to kill 10 percent of the primary buds.
2. Temperatures that have a potential to decrease grape yield.
3. Refers to temperatures likely to kill 90 percent of the primary buds.
4. As water freezes, this is given off.
5. The type of heat that goes to the vines.
6. The type of heat that will rise out of the vineyard.

2. Select the following statements which are correct:

____a. Cold air drainage tends to pull warm air down to the soil surface.

____b. Cover crops and trashy soil absorb and release heat readily.

____c. Overhead sprinklers, wind machines, and orchard heaters are used to modify vineyard temperatures.

____d. At night, the soil surface looses heat to the sky.

____e. The purpose of overhead sprinklers is to mix warm overhead air with cool air.

____f. Wind machines and orchard heaters are often used in combination with each other.

3. List five cultural and management practices that will prevent frost damage. Describe each method.

4. Using Table 12, list the T_{10} and T_{90} temperatures for bud burst.

Answer Sheet

Critical Temperature and Frost Control

1. 1 a.
   6 b.
   3 c.
   2 d.
   5 e.
   4 f.

2. a, c, d, f.

3. a. Vineyard site selection--avoid putting vineyards in frost pockets or where there is inadequate air drainage.

   b. Soil surface--a bare, moist soil is desirable. A cover crop or a trashy covered soil gives the least amount of protection.

   c. Overhead sprinklers--as the water freezes on the vine, heat is given off.

   d. Wind machines--wind machines mix warm air located above with the cooler surface air.

   e. Orchard heaters--the heaters give out heat due to radiation and convection.

4. T_{10} - 25°F T_{90} - 16°F

Grape Pests and Pest Control

Unit IX

Unit Goal: The student will become familiar with pests of grape and methods of control.

Unit Objectives: Upon completion of the unit, the student will be able to:

1. Give a list of pests that affect grapes.
2. State whether a specific pest is a weed, plant disease, vertebrate, snail, or insect.
3. Selectspecific characteristics of grape pests.
4. Discuss in writing the affect grape pests have on grape quality or production.
5. State various methods of pest control.
6. Define pesticide.
7. Define the nine categories of pests.
8. Differentiate between contact, stomach, and systemic poisons.
9. List the purposes of the FIFRA Act.
10. Understand the criteria that should be considered before using a pesticide.

Unit Content Outline

I. Pests.
    A. Plant diseases.
        1. Herbicide injury.
            a. 2.4-D damage.

2. Fungal diseases.
    a. dying arm.
    b. powdery mildew.
3. Bacterial diseases.
    a. crown gall.
4. Viral diseases.
    a. tobacco ringspot.
    b. grapevine leafroll.
    c. fan leaf.
5. Physiological disorders.
    a. frost damage.
    b. sale injury.
    c. winter injury.
    d. sunburn.
    e. drought.

B. Insects.
    1. Grape mealybug.
    2. Western flowerthrip.
    3. Blackvine weevil.
    4. Cutworms.
    5. Cottony maple scale.
    6. Click beetle.
    7. Leafhopper.
    8. Consperce stinkbug.
    9. Nematode.

C. Vertebrates.
    1. Gophers.
    2. Rabbits.

- D. Weeds.

II. Pesticides.

- A. Control.
  - 1. Weeds.
  - 2. Diseases.
  - 3. Insects.
- B. Integrated control methods.
  - 1. Mechanical control.
  - 2. Biological control.
  - 3. Resistant varieties.
  - 4. Cultural control.
  - 5. Sanitation control.
  - 6. Legal control.
- C. Pesticide categories.
  - 1. Insecticides.
  - 2. Herbicides.
  - 3. Fungicides.
  - 4. Bactericides.
  - 5. Nematocides.
  - 6. Miticides.
  - 7. Rodenticides.
  - 8. Acaricides.
  - 9. Molluscicides.
- D. Pesticide control methods.
  - 1. Contact poisons.
  - 2. Systemic poisons.

III. Pesticide Law.

- A. FIFRA.

IV. Should I Use Pesticides?

A. Questions to ask yourself.

Suggested Activities:

--Guest lecturer - County Extension Agent

- Local fieldman

--Review sample chemical labels.

--Have interested students study for a private applicator's license.

--Discuss potential chemicals that may be used on the school vineyard.

--Check the vineyard for grape pests.

Information Sheet

Grape Pests and Pest Control

Plant diseases, weeds, vertebrates, snails, and insects are all considered pests because they compete directly with us for food. Of the five groups, only the snails fail to be an enemy of the grapevine.

In this unit, we will discuss the potential pests of grapes from each of the groups listed above and various methods of control.

Plant Diseases

Grape diseases are classified as herbicide injury, grape diseases (fungal, viral, and bacterial) and physiological disorders. (Refer to TM 10)

2,4-D, a herbicide used commonly by wheat ranchers, can be devastating to the industry. Vineyard contamination in the Northwest is often caused by drift. As the bud is expanding, a cupping pattern may occur. Leaves will be reduced in size. Grape clusters will have a variety of berry sizes and colors.

Other specific herbicides can cause damage. Refer to Cooperative Extension Bulletin 0722 for more information.

Fungal grape diseases include dying arm and powdery mildew.

Dying arm (Eutypa Duback) will have stunted shoots with chlorotic leaves that may have brown leaf margins. Flowers usually drop off soon after they emerge. If berries form, they usually abort immediately. The fungus usually enters through a pruning wound.

Powdery Mildew sets white dust-like growth on the leaf or berry. Shoots may take a reddish-brown color. Flowers, if attached, will not set fruit. Young berries will most likely drop while older ones become distorted in shape. Vitis vinifera grapes tend to be more susceptible than American type grapes.

Crown gall is a bacterial disease of concern to the grape industry. In July, symptoms of crown gall becomes noticeable. The vines usually become yellow and the entire trunk may die. Often, the gall can be found just below soil level on the crown. The infection enters through wounds caused by freezing cracks or mechanical injury. Wounds should be treated with pruning seal to prevent crown gall.

Viral diseases include tobacco ringspot, grapevine leafroll, fan leaf, and stem pitting.

Stem pitting causes small callus-like bumps along the stem. Pits occur in the stem in these bumps.

Tobacco ringspot attacks wine grapes. Identification of the disease can only be done under laboratory conditions. Visual symptoms vary from one location to the next.

Many vinifera grapes used to be affected by leafroll. Resistant varieties have been developed. Leaves will show symptoms in August. The leaf tips will curl near the base of the shoot and will become parallel in relation to the shoot instead of perpendicular. The veins will remain green and the leaves may turn red in color on dark colored berry varieties and yellow in lighter colored grape varieties. The vine will produce less tonnage with small amounts of sugar.

Non-certified grape plants may have fan leaf disease. The disease is brought in by infected rootstocks. There is also a possibility that it is caused by nematodes. The leaf symptoms are usually consistent with yellow rings, veins, and a leaf that is shaped like a fan.

Physiological disorders include frost damage, salt injury, winter injury, sunburn, and drought.

Frost damage is frequently isolated to only a few leaves on shoots. The center of the leaf will turn brown and eventually the entire leaf turns brown. Shoots will have the effect of being "burned" back.

Leaf margins will turn brown first and then the entire leaf will begin to turn brown except for the main veins when a plant is injured by excess salt.

Buds, canes, or entire plants can be affected by winter injury. Buds will turn brown. Wood may also change from green to a brownish-green color. Cross cuts of buds and canes may be made if winter injury is suspected.

Sunburn is usually found on vines that have a south or west exposure. Leaves usually turn reddish-brown in the center. Berries normally dry up.

Wine grapes are more resistant to drought than concords. Leaves become a dull greenish-black in color. Often the lower leaves fall off and the upper leaves curl.

Insect Damage

Insect damage can be caused by grape mealybugs, western flower thrips, blackvine weevil, cutworms, cottony maple scale, click beetle, leafhopper, the consperce stinkbug, and nematodes.

Grape mealybug "crawlers" feed under the bark of canes. As they feed, they secrete a honeydew, that along with the black sooty mold, contaminates the fruit. This prevents the berries from being processed.

Western flower thrips over-winter in trash in the vineyard. They will cause russet-like scars on shoots and berries often resulting in splitting of the berry.

Adult blackvine weevils can reduce yields as much as 3 tons per acre. They feed on cluster stems sometimes weakening them enough to fall. Those that are girdled do not size or color correctly. The larvae feed on the roots but normally do little damage.

Cutworms feed on grape buds. They are the larvae of moths. Cutworms remain under the bark or in the soil during the warm days and climb the vines in the evening.

The honeydew excreted by the cottony maple scale is an ideal environment for sooty mold. The mold along with the honeydew damages the leaves and berries. Control of scale should take place when they are in the "crawler" stage. Once they form the shell covering, it is extremely difficult to control them.

Click beetles are wireworms in the adult stage. They damage the primary buds when they emerge in March.

Small, white spots scattered on a leaf may be symptoms of leafhoppers. Eventually, this will turn yellow showing signs of chlorophyll loss. Injury may be limited if the leafhoppers restrict their movement to the "shade" or underneath leaves. Often, an excretion can cause damage to grape berries.

The consperce stinkbug causes berry clusters to shrivel and turn brown similar in appearance to raisins. They feed on stems of berries and clusters.

Refer to Extension Bulletin 0722 for more detail and photographs of the disease agents.

Nematodes

The northern root-knot nematode can be a problem in concord grapes. The primary symptom is root galling. The nematode can be spread by irrigation water, farm equipment, or old infected crop material. Crop rotation, resistant rootstock, and chemicals all aid in the control of the nematode. (Refer to TM 11)

Vertebrates

Gophers and rabbits are examples of vertebrates that damage grapes.

Gophers not only damage the vines by girdling them on the trunk. They can also disrupt irrigation by digging furrows. They are controlled by traps and baits.

Rabbits can damage young nursery plants or young plants in vineyards by eating the leaves and bark. A mesh fence buried 6 inches in the ground and 3 feet high can be used to control rabbits.

Weeds

Weeds must be controlled in vineyards as they compete for water, nutrients, and interfere with harvesting.

Weeds can be controlled by mechanical methods such as discing between the rows or by using a "grapehoe" attached to a tractor that cleans weeds within the grape row. Herbicides are chemicals that are used to control weeds.

Many other diseases such as grape phylloxera have been problems in vineyards of California. Rootstock has been developed that is resistant to this problem. Washington State has been fortunate not to have had to face the root louse or other viral diseases because pathologists feel the cold winters have held many insects and diseases in check.

Pesticides

Pesticides are chemicals used to control diseases, insects, and weeds. History has shown us that repeated misuse of chemicals have contaminated the environment and caused pests to develop certain resistance to specific chemicals.

Vineyardists should integrate various methods of control to halt the damage caused by pests. These include using mechanical control, biological control, resistant varieties, cultural control, sanitation, and legal control. (Refer to TM 12 and 13)

Rabbits can often be a problem to young plants. The young plant often has to be protected by milk cartons or other mechanical methods.

Biological control is done by bringing in natural enemies of the pest.

The grape industry has introduced many rootstocks that are resistant to grape pests such as phylloxera.

Certain crops may be hosts to certain plant diseases. A wise cultural practice would be to follow a correct crop rotation before planting grapes.

Improper sanitation or failure to keep vineyards clean of dead and decomposing plants may lead to an increased population of undesirable insects.

Legal controls such as inspections or guarantees can protect areas from being infected by pests from other areas.

Pesticides are categorized as:

1. Insecticides - used to control insects.
2. Herbicides - used to control weeds.
3. Fungicides - used to control disease caused by fungi.
4. Bactericides - used to control disease caused by bacteria.
5. Nematocides - used to control nematodes.
6. Miticides - used to control mites.
7. Rodenticide - used to control rodents such as rats, mice, and other small animals.
8. Acaricides - used to control ticks and spiders.
9. Molluscicides - used to control slugs and snails.

Pesticides are often classified according to the way they control the pests. The three methods are by using contact poisons, stomach poisons, or systemic poisons. Contact poisons destroy pests when it comes in contact with the pests. Systemic poisons are absorbed by the plant without harming the plant. As the pests feed on the plant, it permits the pesticide to enter its body. Stomach poisons are ingested directly into the stomach. (Refer to TM 14)

The Federal Insecticide Fungicide and Rodenticide Act (FIFRA) specifies that pesticides: 1. are classified as either general or restricted use; 2. classified as restricted use can only be used by certified people; 3. laws be obeyed and any violation will result in penalties.

Many questions should be answered before a person makes a decision on using a pesticide. They are:

1. How safe is this method?
2. Will the pesticide control the pest as expected?
3. What will the expense be?
4. How much time will it take to produce desired results?
5. What equipment will be needed for application?

In order to safely use chemicals, one must understand chemical labels and the safety practices that must be followed.

Further information can be secured from the Environmental Protection Agency and your local county extension agent.

Pesticide regulations have a tendency to change frequently. Specific chemicals used for pest control were not included in this paper for that reason. Cooperative Extension of Washington State University publishes this information yearly for grapes. The publication is available through your county extension office.

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Name____________________

Test

Grape Pests and Pest Control

1. Match:

____a. dying arm

____b. crown gall

____c. fan leaf

____d. cottony maple scale

____e. western flower thrip

____f. 2,4-D damage

____g. winter injury

____h. cutworms

____i. weeds

____j. physiological disease

____k. sunburn

____l. adult blackvine weevil

____m. powdery mildew

____n. grape mealybug

____o. rabbits and gophers

____p. nematode

1. A plant disease that reduces leaf size. Buds may cup and clusters will have a variety of berry sizes and colors.

2. A plant disease that sets a white dust-like growth on the berry. Berries will drop if young. Older berries become distorted. Wine grapes are more susceptible.

3. Frost damage, sunburn, winter injury, and drought are all examples of this type of disease.

4. This insect secretes a honeydew. This contamination may prevent the berry from being processed.

5. This disease is usually found on vines with a south or west exposure. Leaf centers turn brown and the berries dry up.

6. This insect secretes a honeydew. It is hard to control once they form the shell covering.

7. Root galling is the primary symptom caused by this plant pest.

8. This insect stays in the soil or on the bark during the days. It climbs the vine in the evening and feeds on grape buds.

9. This bacterial disease enters through wounds in the plant. A gall often is found on the crown of the plant.

10. This fungal disease causes the plant to drop their flowers shortly after they emerge. Also known as Eutypa Dieback.

11. This physiological disorder can cause damage to buds, canes, or the entire plant. The buds may turn brown. The wood may also turn brown in more severe cases.

12. This insect thrives in trashy field conditions. Russet-like scars will be found on the shoots and some berry splitting may occur.

13. Yields can often be reduced as much as 3 tons by this insect. It chews on cluster stems, girdling them enough to discolor berries. The clusters may even fall.

14. This viral disease is often attributed to non-certified grape plants. The leaf is going to be shaped like a fan with yellow rings.

15. This pest is often controlled by using a "grape hoe." The pest competes for water and nutrients.

16. These pests are controlled by baits and traps. They damage young grape plants.

2. Select the following statements that are correct:

____a. Winter injury, frost damage, sunburn, and drought are physiological plant disorders.
____b. Pesticides are used to control diseases, insects and weeds.
____c. Chemical pest control is the first method of pest control that should be used.
____d. Plants can be affected by excess salt.
____e. Grape varieties have been developed that are resistant to leaf roll.
____f. Crop rotation is the only effective method of nematode control.
____g. Grape phylloxera is a serious problem to grape farmers in Washington State.

3. Define the following terms:

a. Pesticide.

b. Insecticide.

c. Herbicide.

d. Fungicide.

e. Bactericide.

f. Nematocide.

g. Miticide.

h. Rodenticide.

i. Acaricide.
j. Molluscicide.

4. Differentiate between contact and systemic pesticides.

5. List three purposes of the Federal Insecticide and Rodenticide Act (FIFRA).

   a.
   b.
   c.

6. List five pest gruops that affect grape production.

   a.
   b.
   c.
   d.
   e.

7. Essay (5 pts.).

   What criteria should be considered before using a pesticide?

Answer Sheet

Grape Pests and Pest Control

1. 10 a.
   9 b.
   14 c.
   6 d.
   12 e.
   1 f.
   11 g.
   8 h.
   15 i.
   3 j.
   5 k.
   13 l.
   2 m.
   4 n.
   16 o.
   7 p.

2. a, b, d, e.

3. a. Pesticides - Chemicals used to control diseases, insects, and weeds.
   b. Insecticides - Pesticides used to control insects.
   c. Herbicides - Pesticides used to control weeds.
   d. Fungicides - Pesticides used to control diseases caused by fungi.
   e. Bactericides - Pesticides used to control diseases caused by bacteria.
   f. Nematocides - Pesticides used to control nematodes.
   g. Miticides - Pesticides used to control mites.
   h. Rodenticide - Pesticides used to control rodents.
   i. Acaricides - Pesticides used to control ticks and spiders.
   j. Molluscicides - Pesticides used to control slugs and snails.

4. Contact poisons destroy pests upon contact. Plants absorb systemic poisons into their system. As the pests eat the plant, the chemical enters its body.

5. a. Pesticides are classified as either general or restricted.

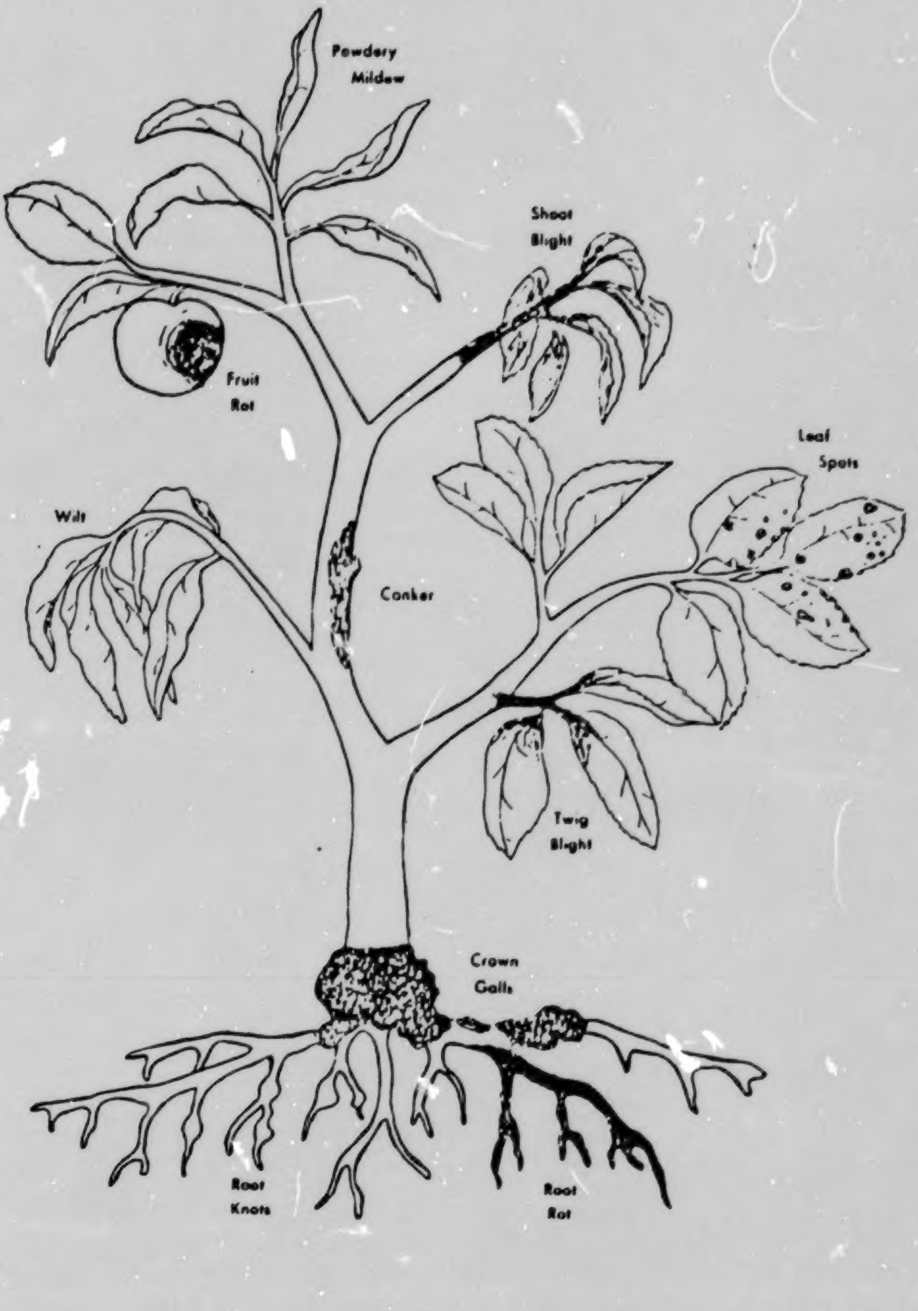
   b. Certified people are legally the only ones that can use restricted pesticides.

   c. Penalties will result if people violate the laws.

6. a. Plant diseases.
   b. Weeds.
   c. Vertebrates.
   d. Snails.
   e. Insects.

7. A person using a pesticide should consider the safety of the product first. They should also determine whether there may be a more economic method of control. Consideration must be given to whether the pesticide will control the pest as expected and if the proper equipment for application is available on his farm. The farmer must also determine whether the product can complete the desired results in the correct period of time.

Symptoms of Diseases


Powdery Mildew
Shoot Blight
Fruit Rot
Leaf Spots
Wilt
Canker
Twig Blight
Crown Galls
Root Knots
Root Rot

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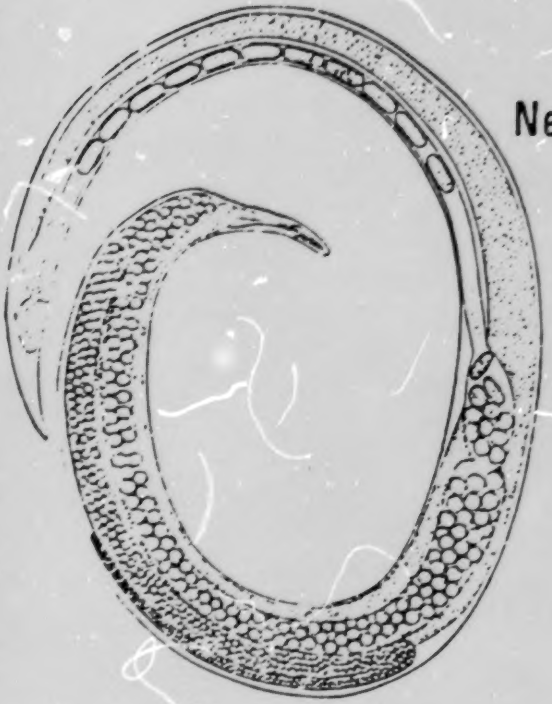
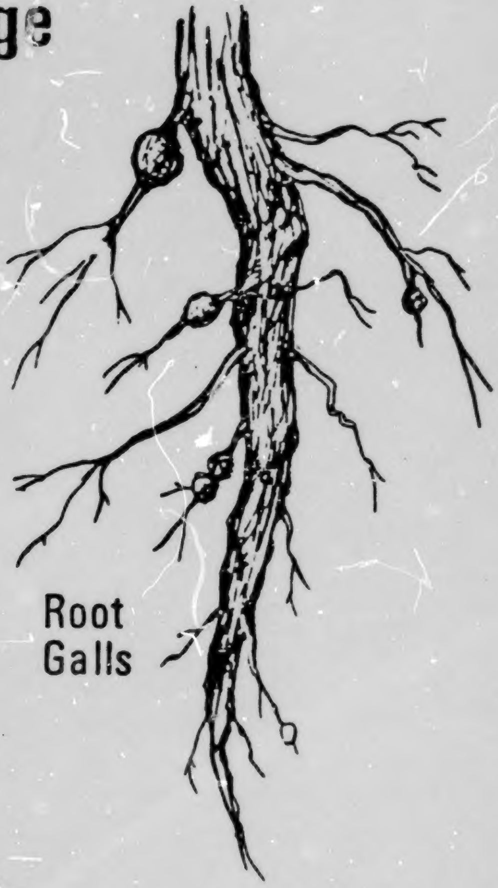
Nematode Damage

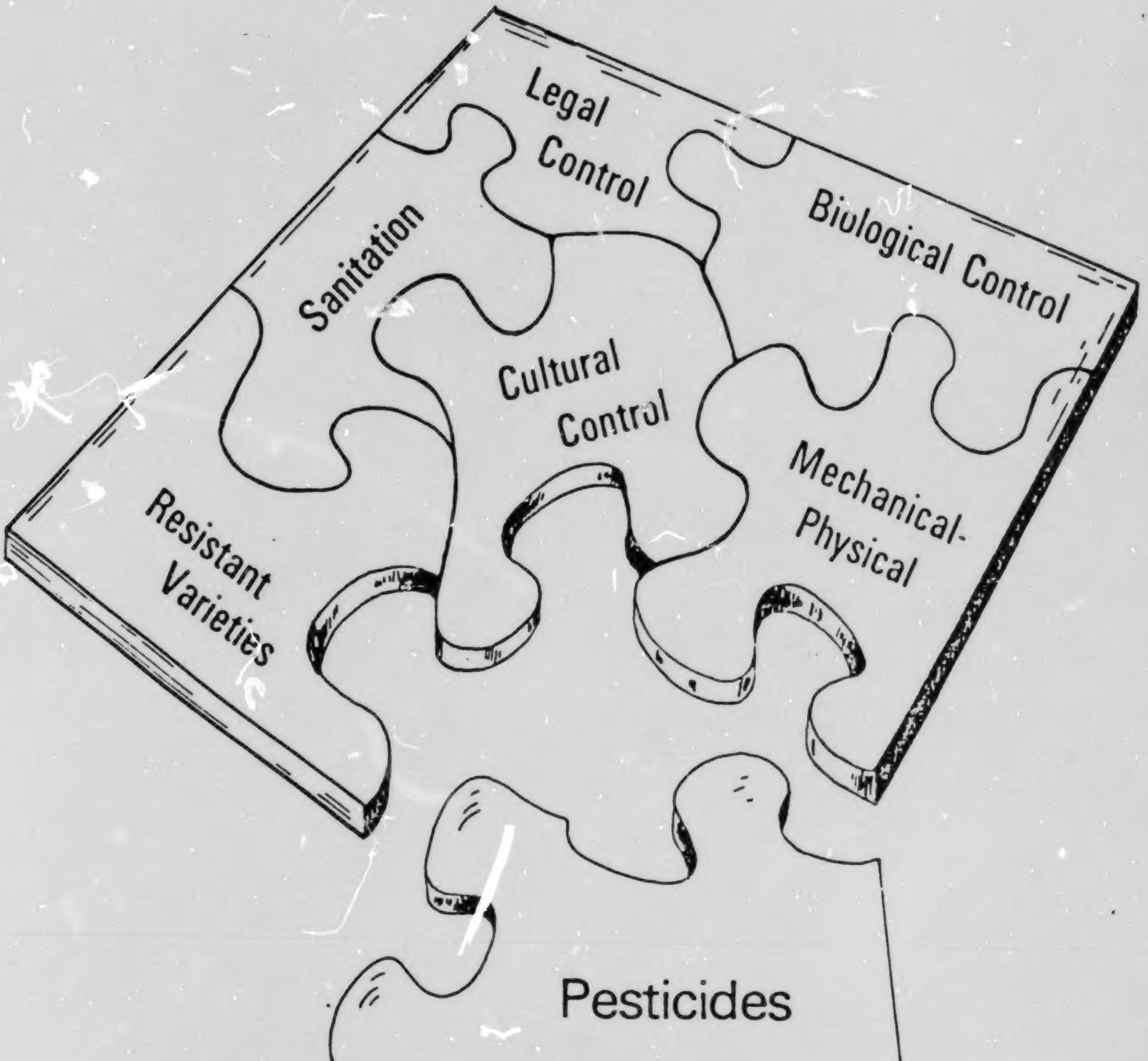


Actual Length Equals 1/50 to 1/25 Inch

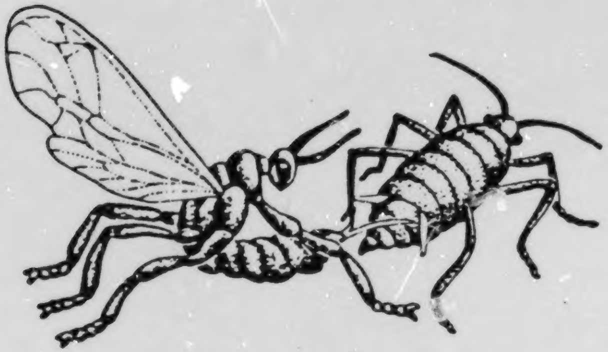


TM 12

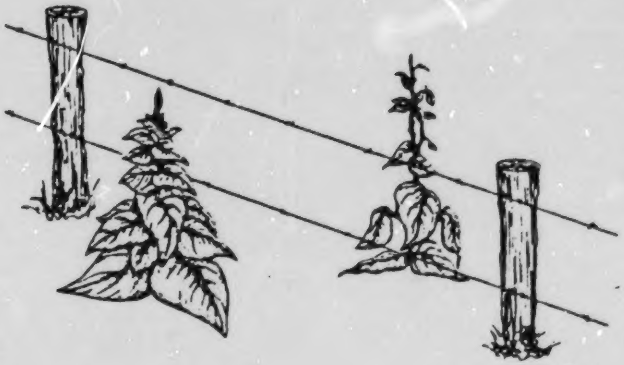
Integrated Control


Legal Control
Biological Control
Sanitation
Cultural Control
Mechanical-Physical
Resistant Varieties
Pesticides

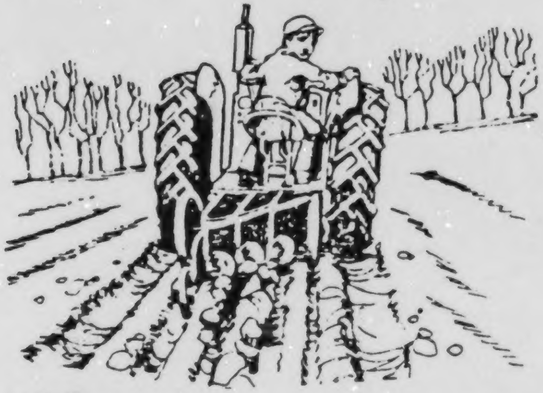
Alternate Control Methods



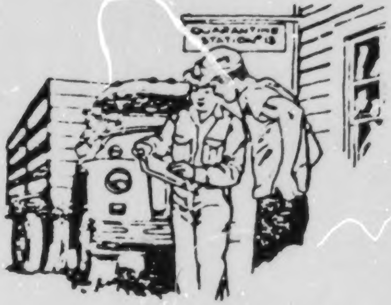
Biological Control



Resistant Varieties



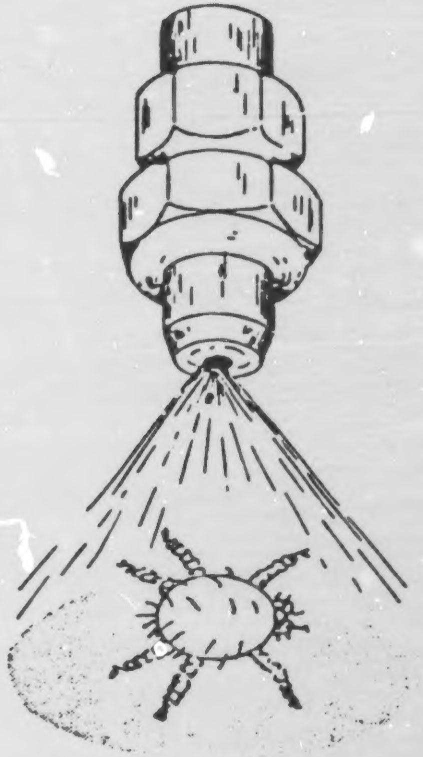
Cultural Control


QUARANTINE STATION

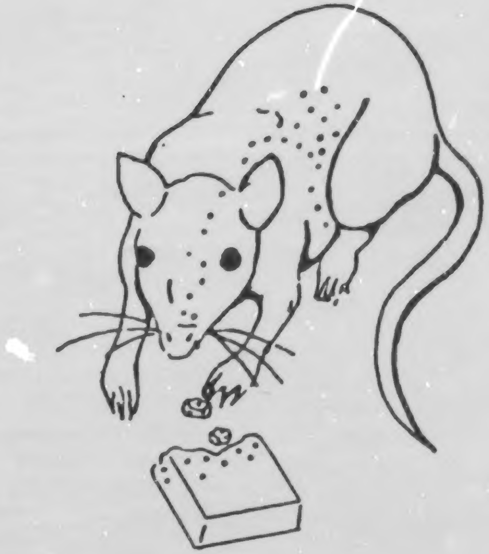
Legal Control

TM 13

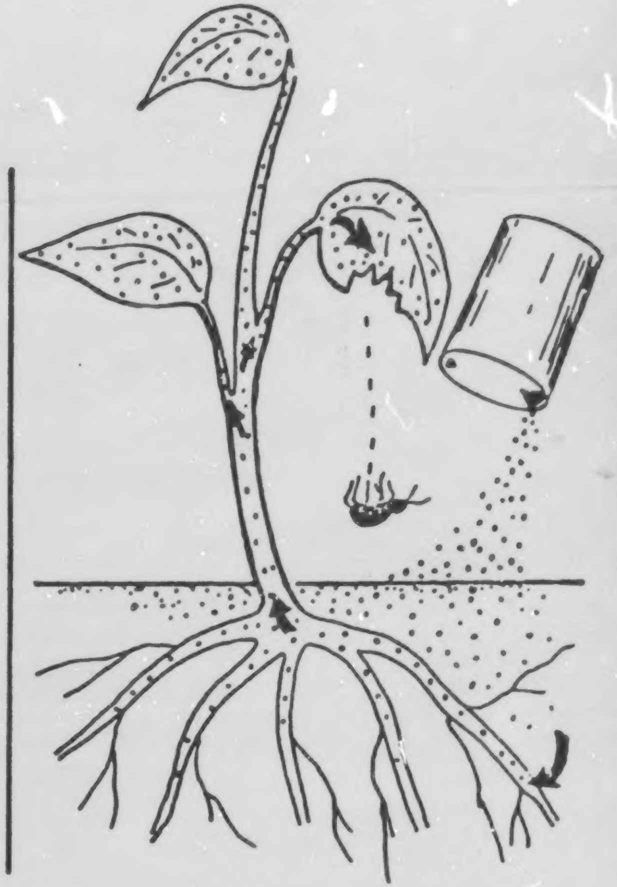
Ways Pesticides Attack Pests



Contact Poison



Stomach Poison



Systemic Poison

TM 14

Methods To Improve Grape Quality

Unit X

Unit Goals: The student will become familiar with physical and chemical methods of improving grape quality.

Unit Objectives: Upon completion of the unit, the student will be able to:

1. Identify physical methods that affect grape quality.
2. List chemicals that affect grape quality.
3. State the purposes of chemicals used to improve grape quality.

Unit Content Outline:

I. Girdling.
    A. Purpose-increase berry set.
II. Plant Growth Regulators.
    A. SADH (Alar)-increase grape set.
    B. Ethylene-hastens maturity.
    C. Gibberellins-thins grapes.
    D. Hand thinning.
    E. Limited use.

Suggested Activities:

--Use the chemicals on different plants within the school vineyards to study chemical affects.

Information Sheet

Methods to Improve Grape Quality

Girdling is the complete removal of a ring of bark 1/8" - 1/4" wide from around the trunk or arm of a grape plant. Although no longer used to a great extent, it was once used to increase berry set. (See TM 12)

Plant regulators such as gibberellins and SADH (Alar) can increase grape set in concords. Alar is the only one used with any frequency. It is used on vigorous vines and inhibits vegetative growth. Ethylene (Ethephon Spray) is a chemical agent that hastens grape maturity. This chemical is used infrequently in Washington State vineyards.

Grapes are sometimes thinned to increase the quality of the grapes and hasten maturity.

The grapes can be thinned by flower-thinning, cluster thinning, or berry thinning. The thinning can be done by chemicals called gibberellins or by hand.

It must be noted that few chemicals, with the exception of Alar, are used primarily because of the high cost of application.

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Weaver, Robert J. "Grape Growing," John Wiley and Sons, New York, New York.

Name______________________

Test

Methods to Improve Grape Quality

1. Match:

   ____a. Girdling

   ____b. Vegetative Growth

   ____c. Alar

   ____d. Thinning

   ____e. Ethylene

   1. The only plant growth regulator used with frequency in Washington State vineyards.

   2. A method of increasing grape quality and hastening maturity.

   3. Removing a ring of bark to improve berry set.

   4. This chemical can be used to hasten grape maturity.

   5. Alar is used to inhibit this type of growth.

2. State the primary purpose for each of the following methods used to improve grape quality.

   a. SADH (Alar) -

   b. Ethylene -

   c. Girdling -

   d. Gibberellins -

3. List the main reason chemical growth regulators are so infrequently used.

Answer Sheet

Methods to Improve Grape Quality

1.
   - 3 a.
   - 5 b.
   - 1 c.
   - 2 d.
   - 4 e.

2. a. SADH (Alar) - increases grape set.

   b. Ethylene - hastens maturity.

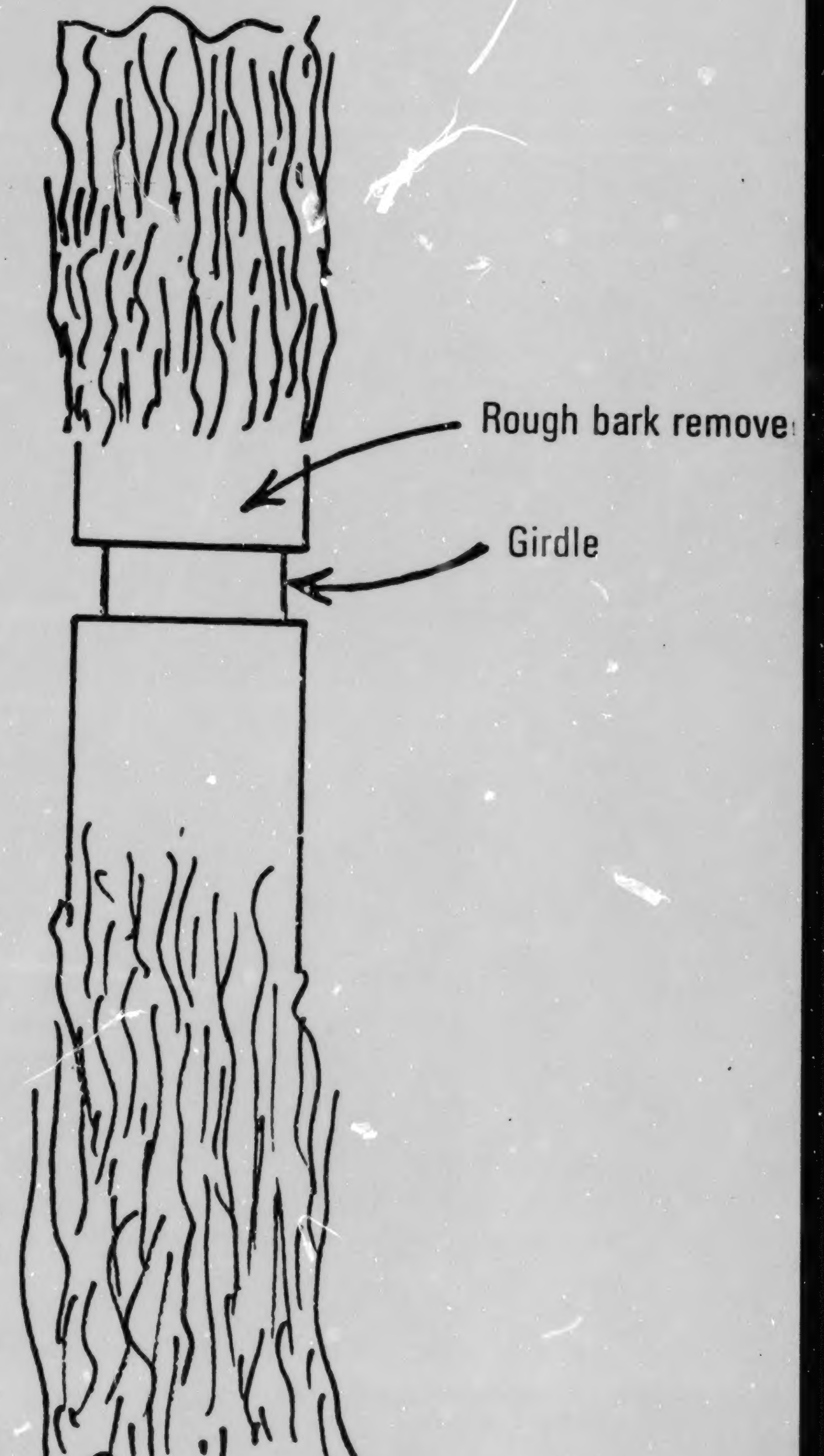
   c. Girdling - increases berry set.

   d. Gibberellins - thins grapes.

3. Too expensive.

Trunk Girdle

TM 15


Rough bark remove
Girdle

Training, Pruning, and Trellising

Unit XI

Unit Goal: The student will become familiar with the interrelationship of grape plant vigor and methods of pruning, training, and trellising.

Unit Objectives: Upon completion of the unit, the students will be able to:

1. Determine the proper pruning techniques for grapes to enhance a vine of proper shape that will enable other cultural practices.
2. Regulate the amount of wood left on different grape types to enhance productivity and grape production.
3. Regulate the amount of production to insure grape quality.
4. State reasons for pruning.
5. Define terms related to pruning.
6. Understand the fruiting habits of the grape plant.
7. Identify trellising systems used in producing European and American type grapes.

Unit Content Outline:

I. Training Systems.

  A. Bilateral cordon training.

    1. Advantages.

  B. Cane training.

    1. Advantages.

    2. Disadvantages.

  C. Bilateral cordon training system.

    1. First year.

      a. two buds.

      b. guided upward.

2. Second year.
   a. prune.
   b. select two branches.
   c. guide along wire.
3. Third year.
   a. leave 20-30 buds.
   b. beware of over production.
4. Fourth year.
   a. prune alternatively to onw and four buds on American types.
   b. prune alternatively to one or two buds on European types.

D. Cane training system.
1. First year.
   a. two buds.
2. Second year.
   a. select single vine.
3. Third year.
   a. select two to four canes.
   b. Select renewal spurs.
4. Fourth year.
   a. four to six renewal spurs.
   b. replacement canes of the future.

II. Pruning.

A. Definition.

B. Reasons for pruning.

- C. Terms.
    - 1. Trunk.
    - 2. Arms.
    - 3. Canes.
    - 4. Renewal spur.
    - 5. Bud.
    - 6. Suckers.
    - 7. Shoots.
- D. Fruiting habit.
- E. Balance pruning (concords).
    - 1. Vine vigor.
    - 2. Fruitfulness.
- F. European pruning recommendations.

III. Trellising Systems.

- A. Considerations in selection.
    - 1. Harvesting method.
    - 2. Plant vigor.
    - 3. Market.
- B. American type trellising systems.
    - 1. Line posts with two wires.
    - 2. Line posts with single wire.
    - 3. Kniffin system.
    - 4. Double curtain system.
    - 5. "T" trellis system.
- C. European type trellising systems.
    - 1. Fan system.
    - 2. Line posts with two wires.
    - 3. "T" treillis.

D. Anchoring methods.

   1. "H" system.
   2. "V" system.
   3. Vertical end post.

Suggested Activities:

--Develop an Agriculture Department vineyard.

--Demonstrate pruning, training, and trellising techniques as part of the "hands on" portion of the program.

--Construct anchors in the shop.

--Try to stagger the grape plantings, so that each class has an opportunity to see different stages of growth.

Information Sheet

Training, Pruning, and Trellising

In Washington State, two training systems are of importance. Most commercial vineyards are either bilateral cordon pruned or cane pruned.

Most vineyardists tend to favor bilateral cordon training because it: 1) offers frost protection because of wood maturity, 2) is the easiest system to maintain once it is established, and 3) is adaptable to mechanical harvesting.

Cane training is used because of similar reasons to cordon training. There are distinct disadvantages to cane training. They are: 1) most difficult system to keep up, 2) difficult to establish, 3) thought to cause some varieties to overbear, and 4) susceptible to frost damage.

Bilateral Cordon Training System

After the grape plant is planted, cut back to two buds. The best branches should then be guided upward toward the trellis. This will be the trunk of the plant.

During the second year of growth, the vine should be pruned in the dormant season. The better branches should be tied to the wire and the rest removed. When spring comes, the two strongest branches that are 6-9 inches below the wire should be guided along side the wire. All growth that develops below these two should be removed. Refer to TM 16 a, b, c.

During the dormant season in the third year, twenty to thirty buds should be left on each plant. Leaving more buds may cause overproduction thus lessoning production in future years.

During the fourth year, the canes that were produced during the third year should be left for cordon arms.

The cane growth on the cordon arm should be pruned alternatively from one bud and four bud canes. The one bud canes are used as renewal spurs for next year's crop. On European grapes, only one or two buds is left on each cane that is pruned.

Cane Training System

During the first year, the established rooted vine should be cut back to two buds.

As we approach the second year, a single strong, vigorous cane should be cut two to five buds above the bottom wire on the trellis.

Two, three, or four canes should then be tied to the trellis. As many as twice as many renewal spurs should be selected. These renewal spurs should be selected due to the spur position (upward), size (the larger the wood in diameter, the more buds are left) and the maturity of the wood.

As the fourth year of development comes around, four to six replacement canes are selected. Renewal spurs are again left and one and one half times as many spurs as canes from last year. These spurs will be the replacement canes of the future.

Suckers that are found on plants should be removed. These suckers will use nutrients that should be used in fruit production. (See TM 17)

Pruning

Pruning is the removal of canes, shoots and other grape vine parts to increase yield, grape size, and quality. It is essential that pruning is not overdone or incorrectly done. Over production, low sugar, and general low quality of grapes is a result of too little pruning. The elimination or reduction of thinning costs coincides with pruning.

To completely understand pruning and training, one must have an understanding of grape terms and the fruiting habit of the grape plant. (See TM 17 and 18)

First, let us discuss terms.

Trunk--The main stem of the vine. It arises from the roots.

Arms--Are branches older than one year.

Canes--The wood produced the previous season.

Renewal Spur--are spurs used to produce fruit the next year.

Bud--A compound bud which contains the primary, secondary, and tertiary buds located in the exil of each lear.

Suckers--Non-fruitful shoots that spring from the base of the trunk.

Shoots--Current season's growth.

Grape bunches are produced laterally on shoots. Most bunches are found on the basal five to six buds. A shoot that produces fruit may come from any bud. Generally, the most fruitful buds are found on shoots originating on the fifth to tenth buds. The most productive wood is one-year old wood that arises from two-year old wood.

"Balance Pruning" is a term used to describe the relationship between the vines' vigor and its capacity to be fruitful and still properly mature the shoot and fruit in the fall.

An accepted practice is to leave fifty buds on the vine for the first pound of prunings removed. Another 10 buds are left for each additional pound (70-90 buds are normally left).

Unlike the Concord grape plant, pruning is distinct with wine grapes.

European varieties needed to be pruned much more severely.

The following numbers of buds left at pruning have been recommended.

Chenin Blanc	35-45
Grenache	"
Semillon	"
Merlot	40-50
Muscat Blanc	"
Carbennet Sauvignon	50-60
White Riesling	"
Chardonnay	"
Pinot noir	"
Gervurztraminer	"
Sauvignon Blanc	60-80

Trellising System

Much consideration should be given to the type of trellising system used. The type of harvesting method, plant vigor, and market are all given consideration when selecting a system.

Currently, there are several types of trellising systems being used in Washington State. Many are adapted to American type grapes while others are more adaptable to wine grape varieties.

American Type Grape Trellising Systems

Many of the states' older vineyards use a system called line posts with two wires. Originally, it had been designed for mechanical harvesting but met with little success because the stakes were not strong enough for mechanical harvesters. In this system, the six foot stakes are buried two feet into the ground. The wires are placed at 34 and 48 inches. (See TM 19)

Line posts with a single wire is used with frequency in concord vineyards. The system uses 7 ft. posts with two feet buried. The wire is put across the top of the post. Often, full exposure to the sun is not permitted due to the canopy. The posts are spaced evenly, approximately every 2-3 plants. (See TM 19) The system is inexpensive to established and facilitates mechanical harvesting.

The Kniffin system is commonly used in producing American type grapes. With this system, 7 ft. posts are buried two feet into the soil. Wires are placed across the top of the post and 36" above ground level. (See TM 19)

The double curtain system is the most expensive of the trellising systems to facilitate. The system was designed to increase yields.

The system is mechanically harvested; thus, the system has to be established with care. The lower wire is used to support the trunk. The pests are 8 feet long and buried two feet into the ground. Attached about 18 inches below the top of these posts are two flexible arms which support wires at the outer ends. These wires support most of the vine canopy and cluster weight and are usually heavier gauge wire (#10 gauge or heavier). (See TM 20)

The "T" trellis system offers higher yields due to increased exposures of the foliage to sunlight.

The "T" system is a three-wire system. (See TM 20) The posts are placed according to vine vigor. The posts are 8 feet long and placed two feet in the ground.

A wire is placed five feet above the soil to support the trunk. At the top of the posts are 2" x 4" boards, three feet in length. These support the wire that is to support the fruiting vines.

Adjustments may have to be made to adapt this method to mechanical harvesters.

European Type Grape Trellising Systems

Many of the older wine grape vineyards were trained to the "Fan System." The system uses four trunks all brought up from ground level. The trunks and canes were attached to a modified "Kniffin" type of system.

The primary purpose of the system was to untie the vines and lay them on the ground to be covered with soil for winter protection. As wine grape vineyards grew in size, this practice became impractical. (See TM 19)

Most new vineyards are using a bilateral cordon training system. Depending upon the vigor of the vine, the grape plants are spaced six feet between rows. The 7 foot posts are buried two feet into the ground. Wire is placed at the top of the post and at 46 inches above ground level. The lower wire supports the fruit while the top wire supports the new vine growth. This trellising method is referred to as line posts with two wires.

The "T trellis is also used in wine grape vineyards. Unlike the "T" system used in concords, this system uses 4 wires. On the top of the posts a wire is added to prevent new growth from being blown to one side. If this were not done, there is a possibility the added weight may damage the system.

Anchoring the trellis systems is extremely important. Stress due to fruit weight, vine weight, and wind could damage a trellising system if it were not anchored properly. Mechanical harvesting is often abusive to trellises. Three anchoring systems are recognized. They are "H" system, Inverted "V" system, and anchoring of vertical end post. TM 21 shows the three systems.

References

California Vocational Agriculture Curriculum Guidelines Instructional Unit, "Vine Pruning."

Childers, Norman F. "Modern Fruit Science," Horticultural Publications, Rutgers University, New Brunswick, New Jersey.

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Denison, Ervin L. and Harry E. Nichols. "Laboratory Manual in Horticulture," Iowa State University Pres, Ames, Iowa.

Klein, Joel K. "Wine Production in Washington State," Chateau Ste. Michelle, Woodinville, Washington.

Name ____________________

Test

Training, Pruning, and Trellising

1. Match:

____a. Plant stake - 2 wires

____b. Fan system

____c. Bilateral cordon

____d. Pruning

____e. Cane pruning system

____f. Basal 5 to 6 buds

____g. European type

1. Where most grape bunches are found.
2. Many older American type grape vineyards have this type of trellising system.
3. A system originally used in wine grapes.
4. The most popular of the grape training system.
5. This training system does not provide much frost protection.
6. The term given to the removal of canes, shoots, and other grape vine parts.
7. This grape type is pruned the heaviest because of its vigorous growth habits.

2. Select the following statements which are correct.

____a. European grape varieties all require the same number of buds left during pruning.

____b. "Balance Pruning" is used on concord grapes.

____c. European grapes are pruned more severely than American grape varieties.

____d. The "Fan System" double curtain system, kniffin system, and "T" trellis are all methods of trellising American type grapes.

____e. Most grape pruning is done during the dormant season.

____f. The disadvantages of bilateral cordon training are: 1. It is extremely susceptible for frost damage; 2. It is the most difficult system to maintain.

3. Define the following terms:

    a. Trunk.

    b. Arms.

    c. Canes.

    d. Renewal Spur.

    e. Bud.

    f. Suckers.

    g. Shoots.

    h. Balance Pruning.

4. Identify the grape plant parts and training system used in TM 17 and 18.

5. Identify the grape trellising system shown in TM 19 and 20.

6. State three reasons for pruning.

    a.

    b.

    c.

Answer Sheet

Training, Pruning, and Trellising

1. 2 a.
   3 b.
   4 c.
   6 d.
   5 e.
   1 f.
   7 g.

2. b, c, e.

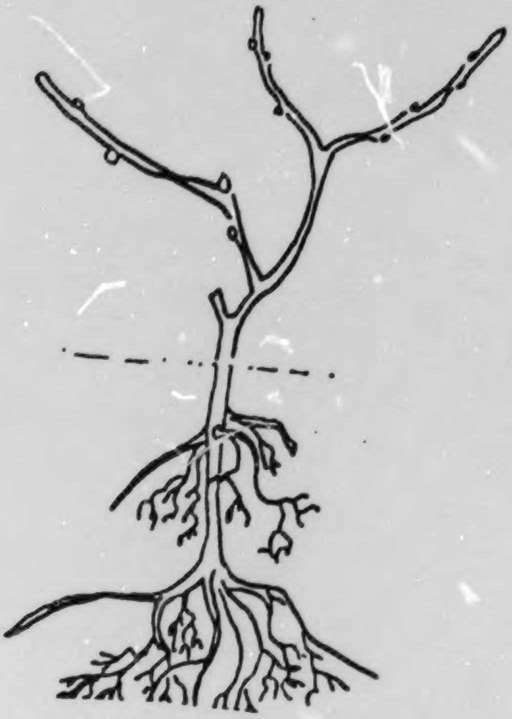
3. a. Truck--the main stem of the vine.
   b. Arms--branches older than one year.
   c. Canes--wood produced the previous season.
   d. Renewal Spur--are cane spurs used to produce fruit the next year.
   e. Bud--a compound bud which contains primary, secondary, and tertiary buds. Located in the leaf axil.
   f. Suckers--non-fruitful shoots that spring from the base of the trunk.
   g. Shoots--current seasons' growth.

4. Refer to TM 17 and 18.

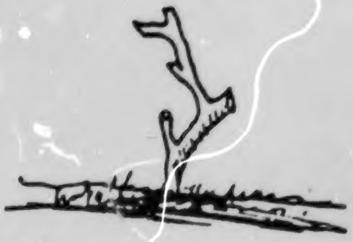
5. Refer to TM 19 and 20.

6. a. increase yields.
   b. increase grape berry size.
   c. increase grape quality.

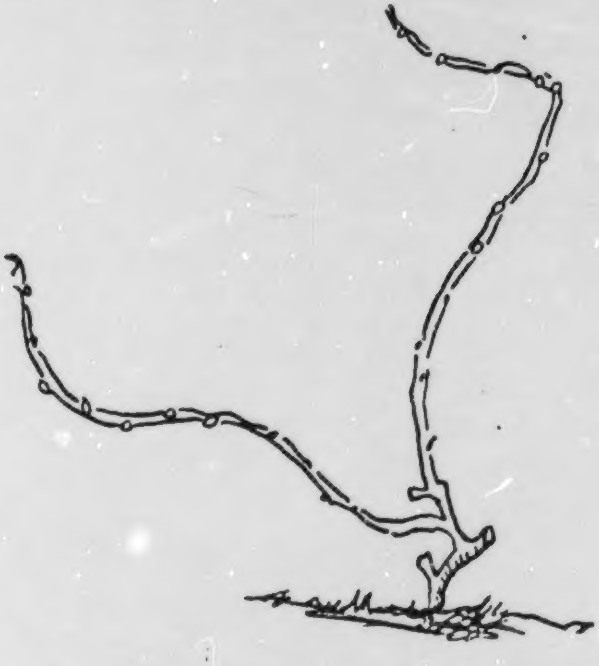
Bilateral Cordon Training



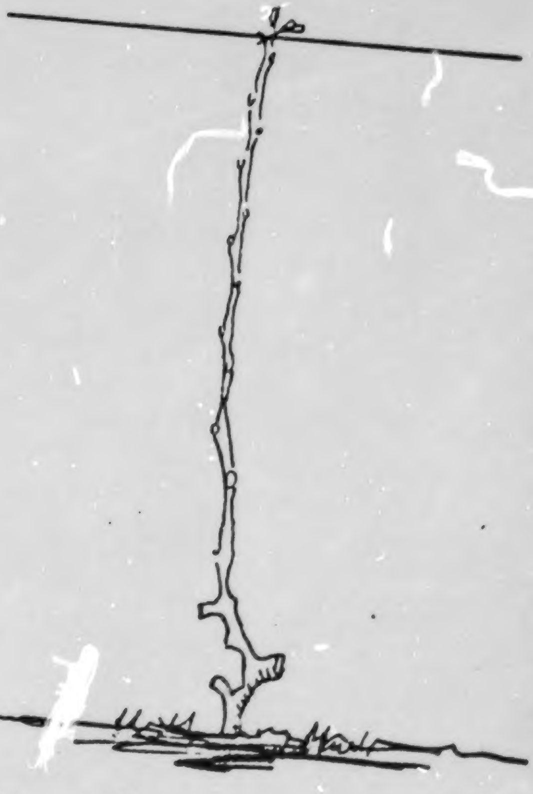
An unpruned vine after planting.



Same vine pruned to 2 buds.



Vine as it would appear 1 year after planting.



Same vine pruned and longest cane tied to trellis.

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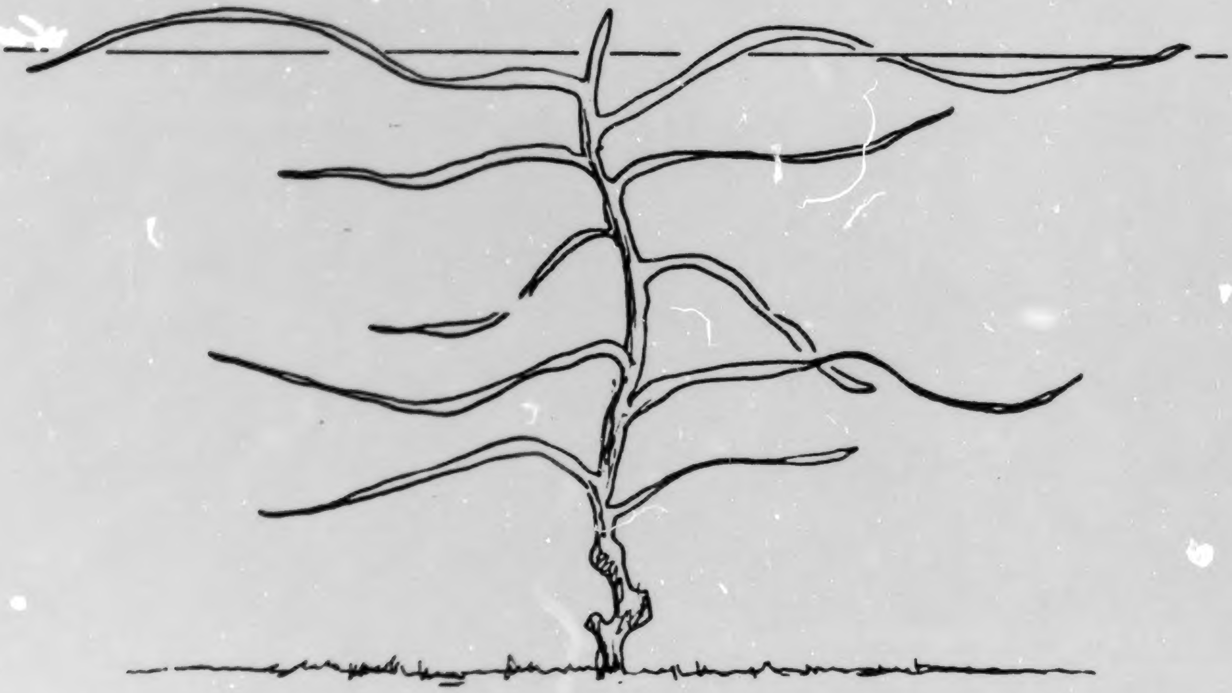
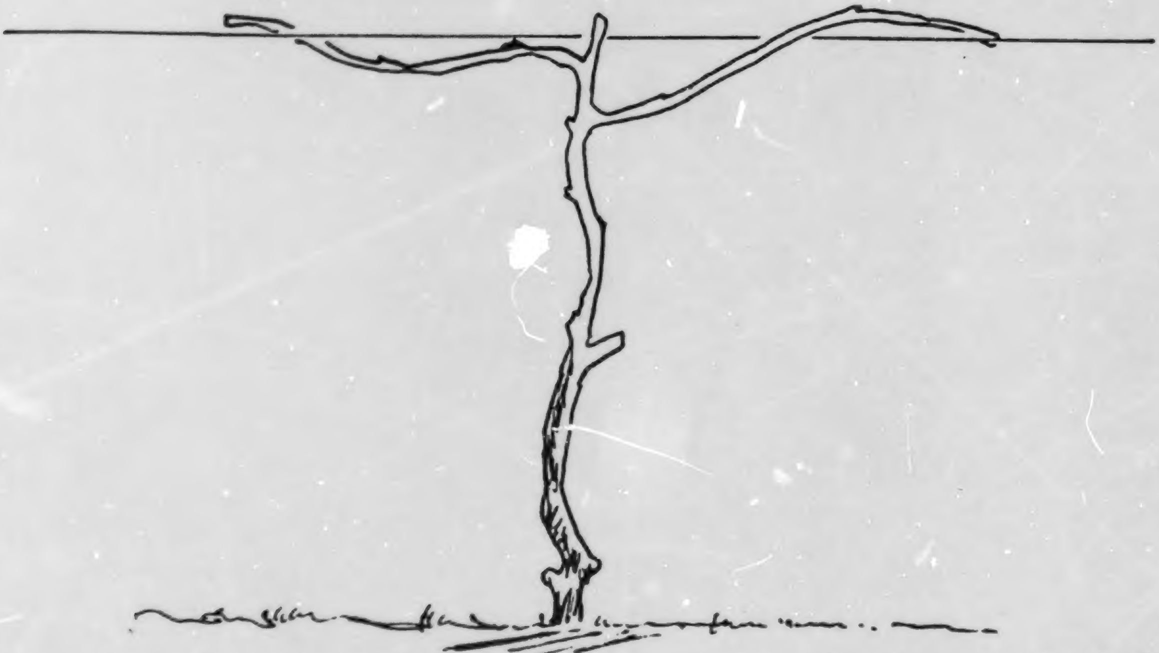


Unpruned vine 2 years after planting.



Same vine after pruning.

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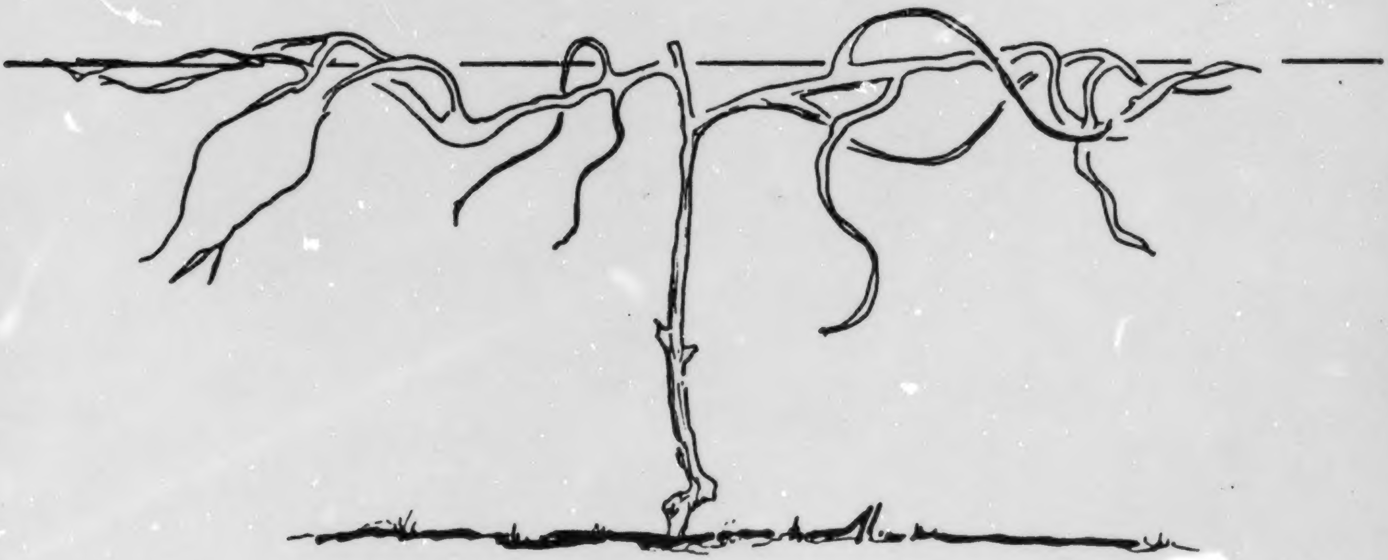
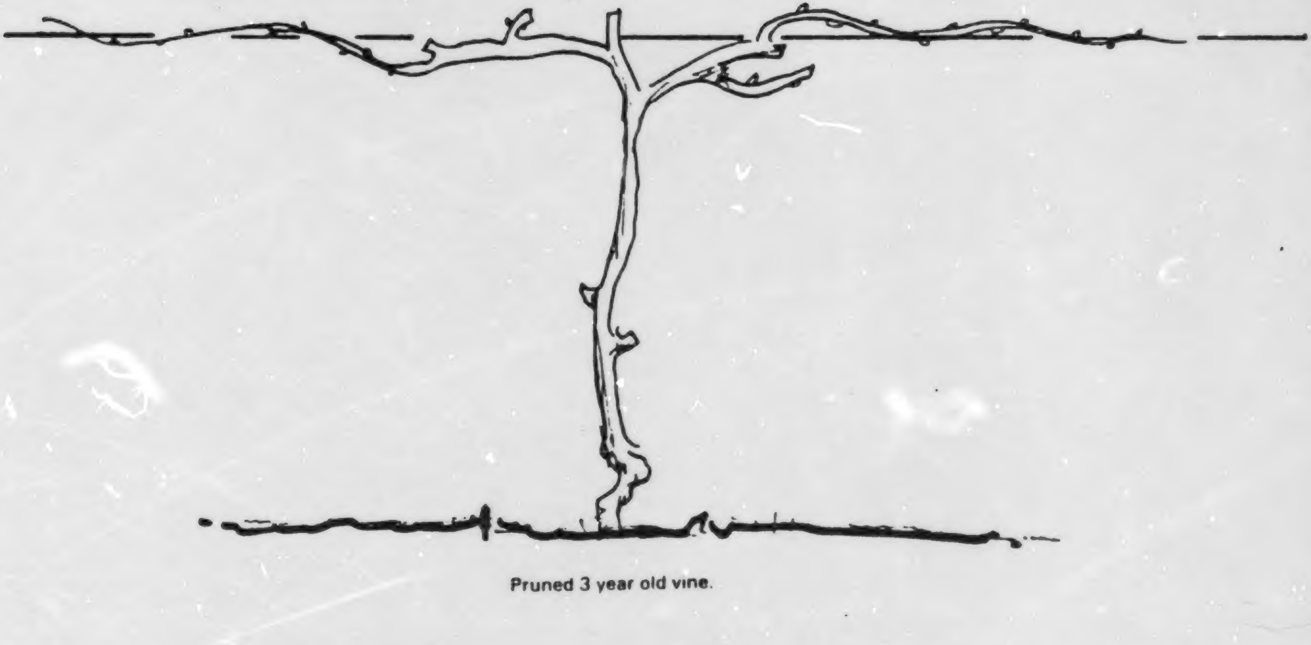


Unpruned vine 3 years after planting.



Pruned 3 year old vine.

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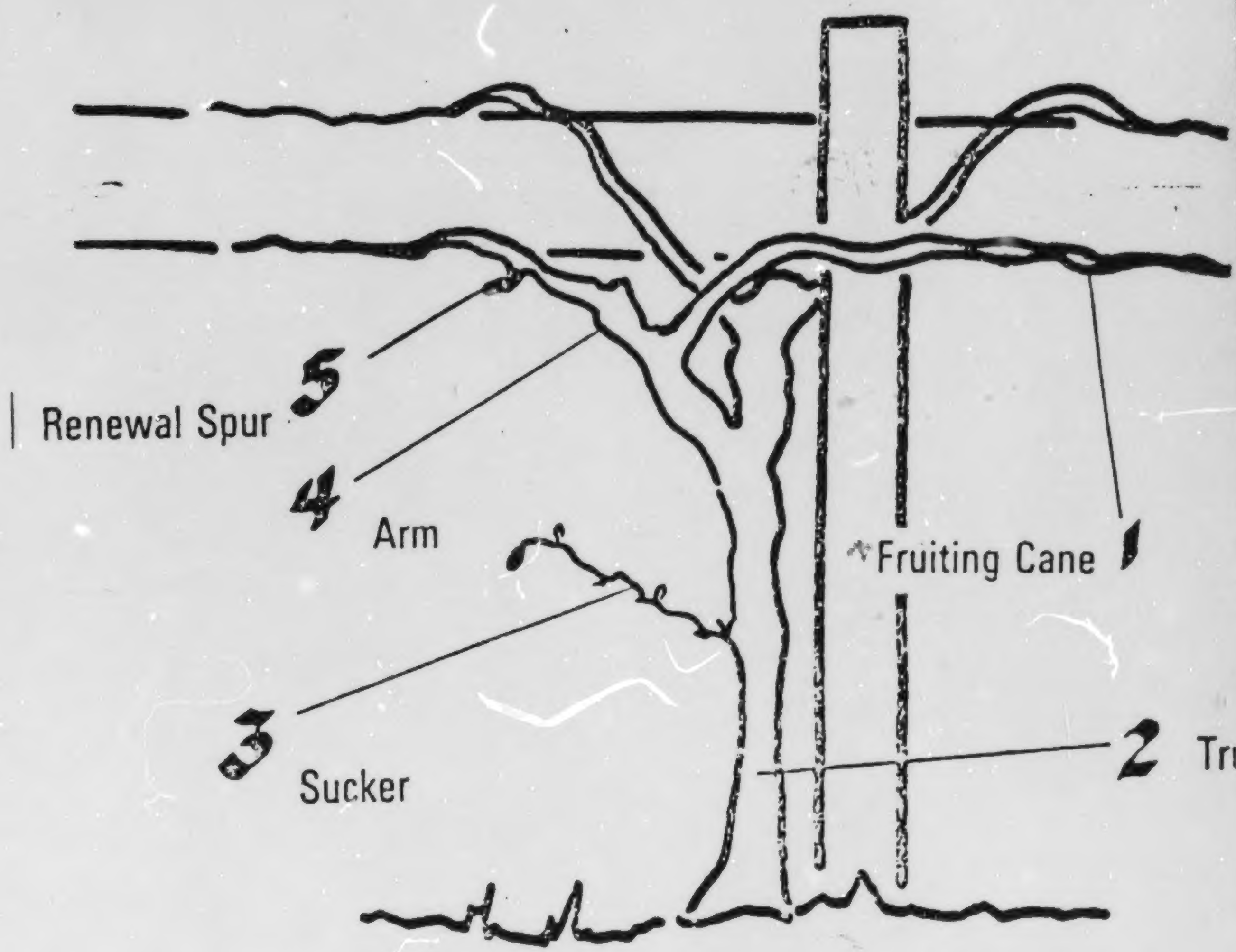
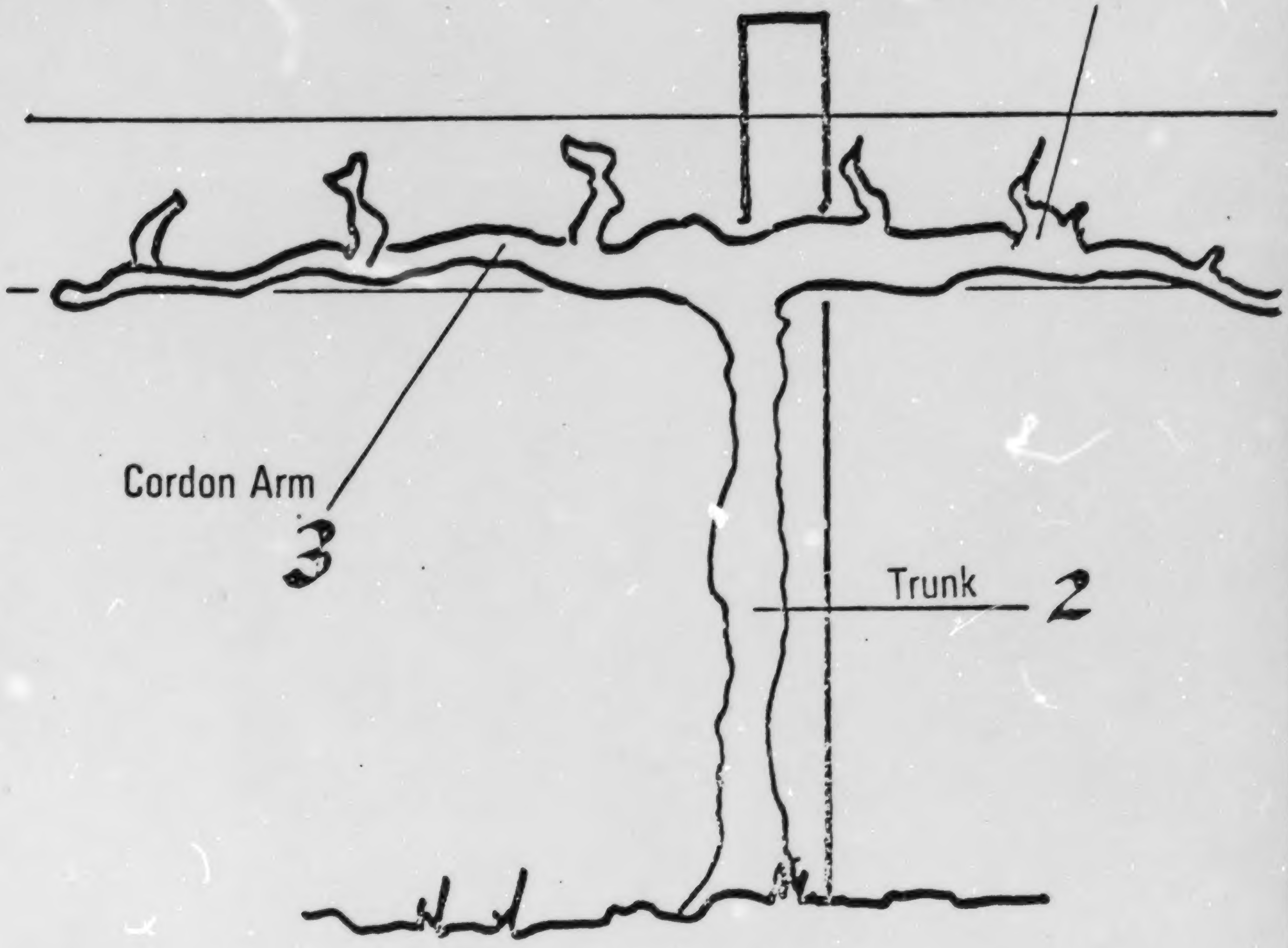
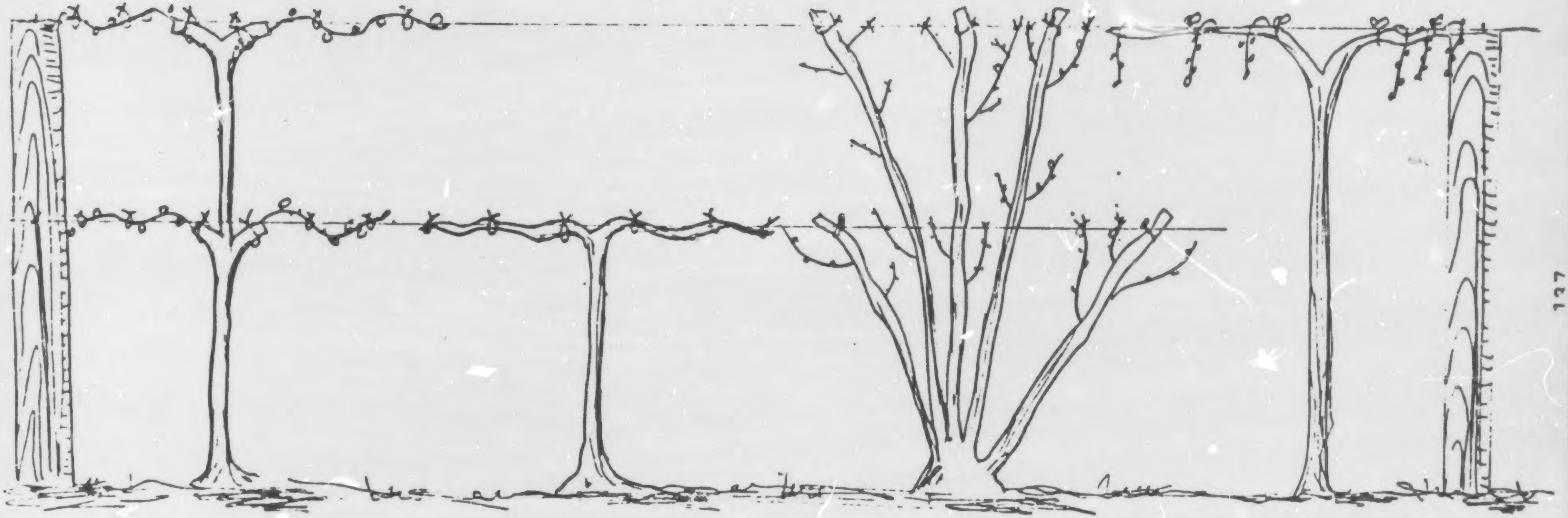

Renewal Spur
5
4
Arm
3
Sucker
Fruiting Cane
1
2
Tr

Cane Pruned


Renewal Spur 1
TM 18
Cordon Arm
3
Trunk
2

Cordon Pruned

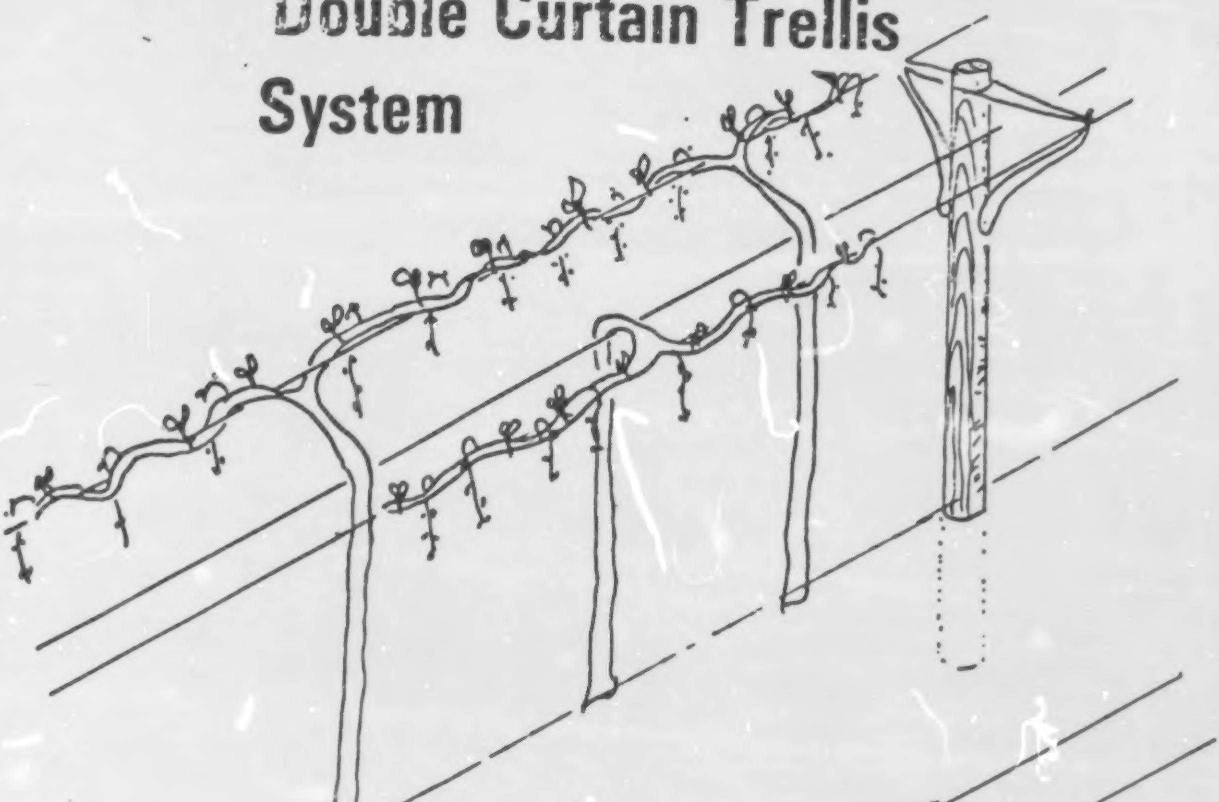
Methods of Trellising


Kniffin System
Line Posts with Two Wires
Fan System
Line Posts with Single Wir

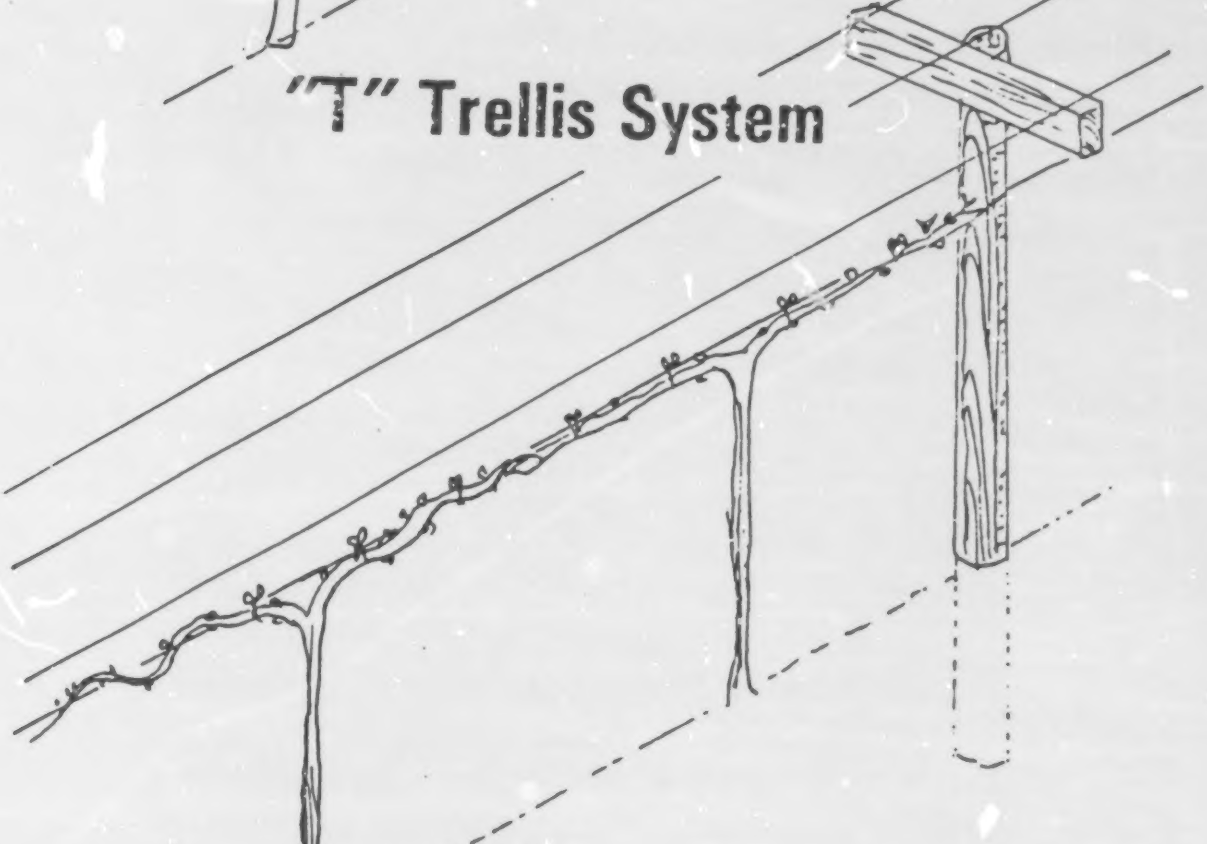
Courtesy: Washington State University

TM 20

Double Curtain Trellis System



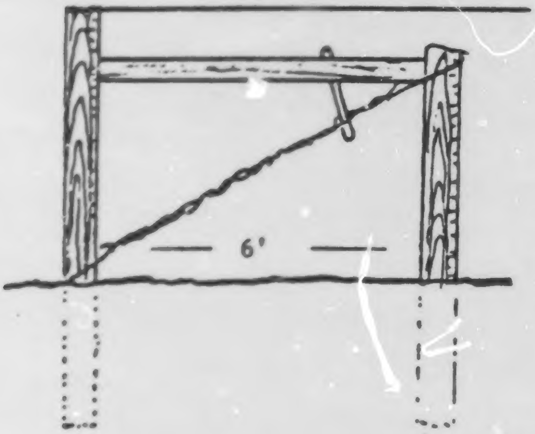
"T" Trellis System



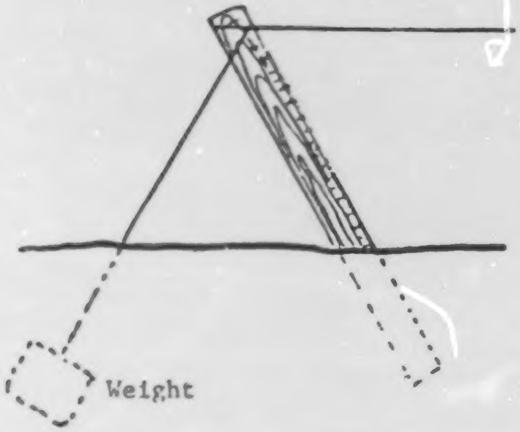
Courtesy: Washington State University

Anchoring Methods

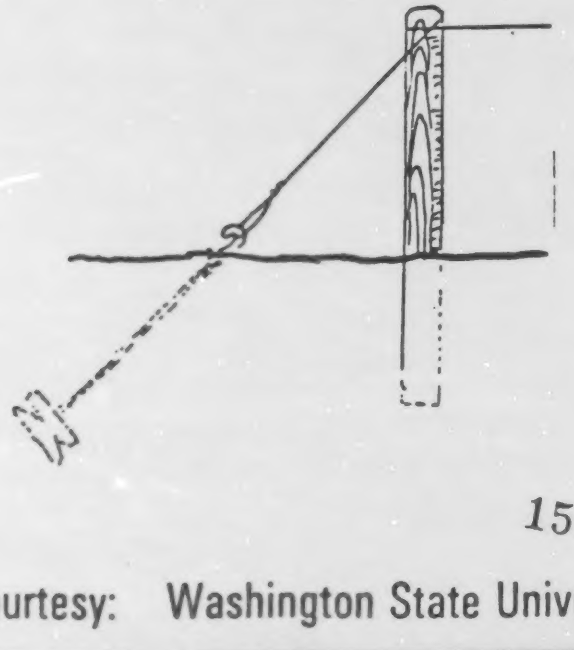
TM 21



H - System



Inverted V System



Vertical End Posts

Courtesy: Washington State University

Irrigation

Unit XII

Unit Goal: The student will develop an understanding of irrigation practices used in grape production.

Unit Objectives: Upon completion of the unit, the student will be able to:

1. List advantages of the various methods of irrigation.
2. List the disadvantages of the various methods of irrigation.
3. Describe briefly characteristics of each system.
4. List factors affecting the frequency of irrigation.

Unit Content Outline:

I. Need for Irrigation.
    A. Average annual rainfall.
    B. Grape plant need.
    C. Deficiency.
II. Factors Affecting the Frequency of Irrigation.
    A. Soil type.
    B. Soil depth.
    C. Method of irrigation.
III. Available Soil Moisture.
    A. Feel and appearance.
    B. Equipment.

IV. Types of Irrigation Systems.

- A. Rill irrigation.
    - 1. Description.
        - a. ditches or furrows.
        - b. Oldest method.
    - 2. Advantages.
        - a. cheap to install.
        - b. adaptability to medium soil texture and uniform slope.
    - 3. Disadvantages.
        - a. high labor costs.
        - b. erosion.
        - c. efficiency.
- B. Solid-set overhead sprinkler system.
    - 1. Description.
        - a. PVC pipe.
        - b. overhead sprinklers.
    - 2. Advantages.
        - a. uniform coverage.
        - b. application of materials through system.
        - c. adaptable to hilly terrain.
        - d. 80-90 percent coverage.
        - e. low labor costs.
    - 3. Disadvantage.
        - a. $1,100/acres cost.
        - b. drift caused by wind.

C. Center-pivot sprinkler system.
   1. Description.
      a. 1/4 mile long.
      b. irrigates 138 acres.
      c. moves in a circle.
   2. Advantages.
      a. uniform coverage.
      b. 80-90% coverage.
   3. Disadvantages.
      a. not adaptable to rolling hills.
      b. drift caused by wind.
      c. $60,000 initial cost.

D. Drip system.
   1. Description.
      a. plastic pipe.
      b. emitters and "spaghetti" tubing.
      c. located at individual plant.
   2. Advantages.
      a. H_2O applied directly.
      b. weed control.
      c. easier harvest.
      d. low labor cost.
   3. Disadvantages.
      a. plugged emitters.
      b. lack of cover crop.

Suggested Activities:

--View different methods of irrigation around the community.

--Use equipment that is used in determining plant water needs.

Information Sheet

Irrigation

Low levels of rainfall in the central portion of Washington State makes irrigation a necessity. The average annual rainfall for the central portion of Washington ranges from 6-10 inches. (See TM 22) Grapes need 24-36 inches of water annually.

A water deficit in grapes reduces grape vine growth. The normal yellowish green color will change to dark green. Drought conditions can often cause young clusters to dry up, or in mature clusters, the berries will reduce in size and weight.

Soil type and depth along with the method of irrigation will establish the frequency of irrigation. Refer to TM 23 for more information. Remember, soil depth and type may vary from one location to another within the same vineyard.

Irrigation normally begins in April and ends in August with European varieties or in September which is frequently the case with concords. Water is often removed early to help induce dormancy in plants.

A person's ability to identify the amount of soil moisture that is available is of utmost importance. The feel and appearance of the soil is one important method. Table 13 can be used to determine soil moisture availability.

The irrigation systems used include rill, solid set overhead sprinkler, center-pivot sprinkler, and drip irrigation.

Rill irrigation, also known as furrow irrigation, is the oldest of the methods used. With rill irrigation, water is channeled through ditches running on the sides of the rows.

Table 13. Judging Soil Moisture Available.

Available Soil Moisture Remaining	Feel or Appearance of Soil			
	Coarse Texture	Moderately Coarse Texture	Medium Texture	Fine and Very Fine Texture
0 to 25 percent...	Dry, loose, single grain, flows through fingers.	Dry, loose, flows through fingers.	Powdery dry, sometimes slightly crusted but easily broken down into powdery condition.	Hard, baked, cracked, cometimes has loose crumbs on surface.
25 to 50 percent...	Appears to be dry, will not fomr a ball[1] with pressure.	Appears to be dry, will not form a ball.[1]	Somewhat cumbly but holds together from pressure.	Somewhat pliable, will ball[1] under pressure.
50 to 75 percent...	Appears to be dry, will not form a ball with pressure.	Tends to ball under pressure but seldom holds together.	Forms a ball somewhat plastic, will sometimes slick slightly with pressure.	Forms a ball, ribbons out between thumb and forefinger.
75 percent to field capacity (100 percent).	Tends to stick together slightly, sometimes forms a very weak ball under pressure.	Forms weak ball, breaks easily, will not slick.	Forms a ball, is very pliable, slicks readily if relatively high in clay.	Easily ribbons out between fingers, has slick feeling.
At field capacity (100 percent).	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand.	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand.	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand.	Upon squeezing, no free water appears on soil but wet outline of bal is left on hand.

---

[1] Ball is formed by squeezing a handfull of soil very firmly.

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The type of system used often depends upon capital that is available to purchase the system. Rill irrigation is the cheapest method to install. Rill irrigation is adaptable to medium textured soils and uniform slopes.

Labor costs for furrow irrigation are generally higher due to the changing of water from one ditch to the next during the irrigation season.

Steep slopes with rill irrigation used can result in erosion problems. Furrow irrigation seldom approaches 50 percent efficiency of water applications.

Limited cultivation is recommended when using rill irrigation. Soil compaction by equipment can limit water penetration.

Rill irrigation is being used less and less as new vineyards are being established.

The solid-set overhead sprinkler system is widely accepted in vineyards. Poly-vinyl chloride pipe or PVC is used extensively for these systems. The pipe is extremely resistant to wear if buried correctly and costs less than aluminum or galvanized pipe. The overhead sprinklers are located in the grape rows. Most sprinkler heads use a 9/64 orifice which operates at 40-60 psi. The orifice size may vary according to the amount of water a person may want to apply in a given area of the vineyard.

The solid-set system has an advantage of uniform water coverage. This is extremely conducive to a uniform cover crop in the fall. This system can also be used for frost control.

Sprinkler irrigation is very adaptable to hilly terrain. sprinkler irrigation often approaches 80-90 percent efficiency of water application.

The costs of a solid-set overhead system may run in excess of $1,100/acre. Drift caused by wind can also be a disadvantage.

One of the most unique methods of irrigation is with a center-pivot, or "circle" irrigation system. The system is one quarter of a mile long and irrigates 138 acres. The wheels of the center-pivot run in a path of less than two feet wide. Orifice size varies along the boom to insure uniform irrigation of the vineyard.

The center-pivot system has all of the advantages of a solid-set sprinkler system.

Anchoring of grape rows is different from a solid-set system as the wheels of the pivot run in a circular pattern which prevents rows from starting and stopping in the same location as is found with other irrigation methods. Costs for a center-pivot are estimated at nearly $60,000 for 138 acres.

Presumably, the most efficient use of water is with the drip system. In the drip irrigation system, plastic pipe is run down the trellis row with emitters located at each plant with "spaghetti" tubing running from each emitter to the plant.

Water is directly applied to the root zone of the plant. This system provides a water-plant relationship that is conducive to more profitable yields. Fertilizers can also be applied through this system. A significant amount of water is conserved through this method of irrigation. The areas between the grape row are dry thus helping in weed control and harvest operations. Irrigation can be continuously going 24 hours a day with very little labor involved.

The success of drip systems depends upon the filtration systems which are necessary to keep debris from plugging the emitters. A drip system alone is not conducive to a cover crop between the grape rows but in conjunction with an overhead sprinkler system can provide the water needed to maintain a cover crop.

References

Gustafson, C. D. "How to Drip Irrigate," University of California, San Diego County, California.

Klein, Joel K. "Wine Production in Washington State," Chateau Ste. Michelle, Woodinville, Washington.

Loreen, C. O. "Irrigation Practices," Coordinating Council for Occupational Education, Olympia, Washington.

Weaver, Robert J. "Grape Growing," John Wiley and Sons, New York, New York.

Name______________________

Test

Irrigation

1. Match:

____1. Furrow irrigation

____2. High labor costs

____3. Uniform water coverage

____4. Irrigation

____5. Drip irrigation

____6. nutrients can be applied.

____7. Center-pivot system.

____8. Emitters and "Spaghetti" tubing.

____9. Dormancy

____10. Solid-set overhead sprinkler system

a. Uses ditches running along side the rows.

b. Removing H_2O induces this.

c. Rill irrigation.

d. Normally begins in April and ends in August.

e. An advantageof the overhead sprinkler system.

f. Poly-vinyl chloride pipe or PVC is used in this system.

g. This method uses water the most efficiency.

h. Also known as "circle" irrigation.

i. Used in drip irrigation.

j. Solid-set overhead sprinkler system.

2. Check those statements that are correct:

____a. The drip system is the most widely accepted irrigation system in vineyards.

____b. Solid set overhead sprinkler systems cost as much as $1,100/acre.

____c. The center-pivot system irrigates 138 acres at one time.

____d. Rill irrigation is applied as often as every week to two weeks.

____5. Irrigation is not necessary in central Washington because of high levels of rainfall.

3. List the advantages and disadvantages of each of the methods of irrigation.

Answer Sheet

Irrigation

1. a 1.
   c 2.
   j 3.
   d 4.
   g 5.
   e 6.
   h 7.
   i 8.
   b 9.
   f 10.

2. b, c, d.

3. Rill irrigation.

   Advantages:
   1. Cheap to install.
   2. Adaptable to uniform slope.
   3. Adaptable to medium texture soil.

   Disadvantages:
   1. High labor costs.
   2. Erosion.
   3. Poor efficiency in coverage.

   Solid-set overhead sprinkler system.

   Advantages:
   1. Uniform water coverage.
   2. Applications of materials through the system.
   3. Adaptable to hilly terrain.
   4. 80-90 percent efficiency of coverage.

   Disadvantages:
   1. Toss of water to wind.
   2. $1,100/acre initial cost.

   Center-pivot sprinkler system.

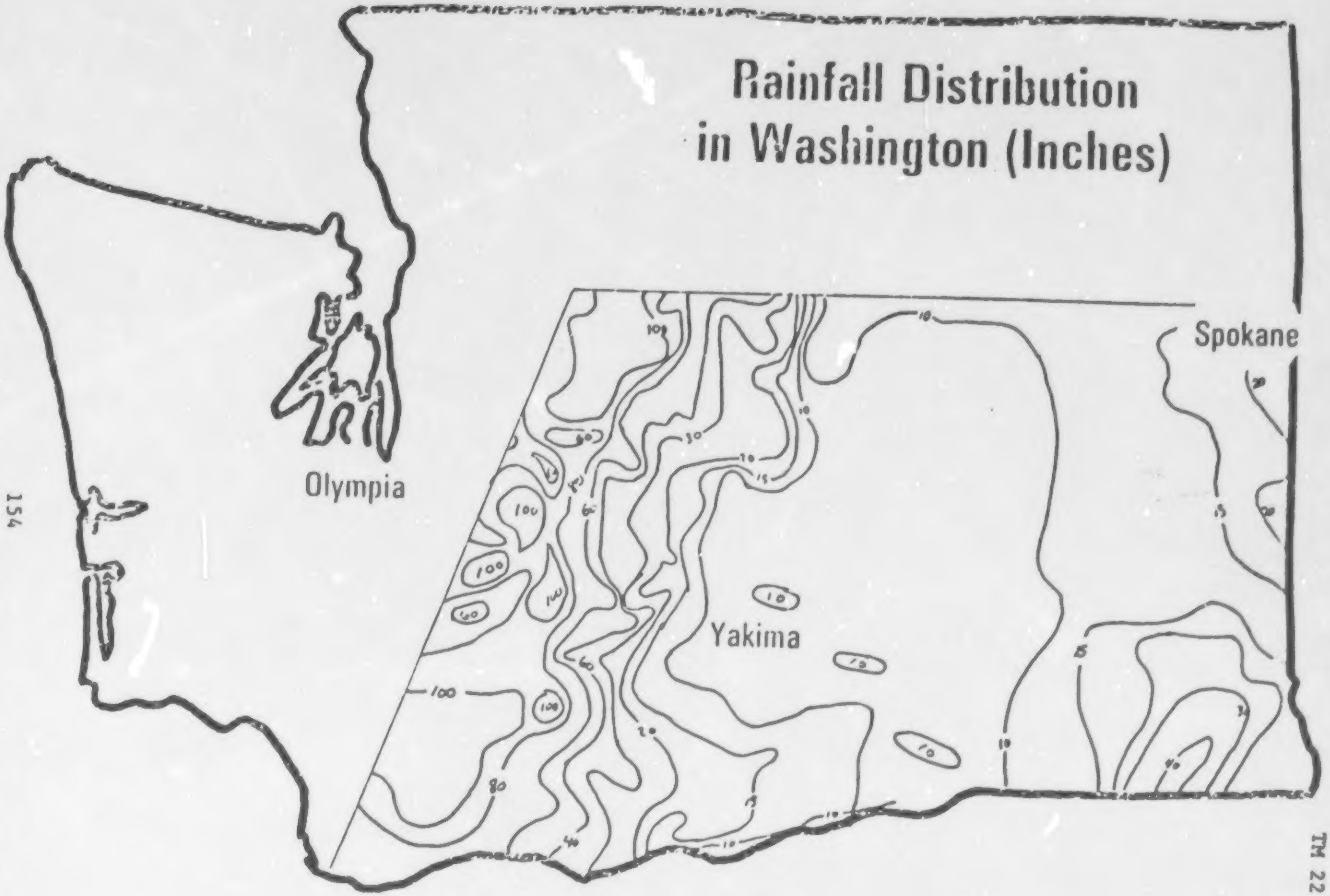
   Advantages:
   1. Covers 138 acres.
   2. Low labor requirement.
   3. Uniform coverage.
   4. Application of fertilizers through the system.
   5. 80-90 percent efficiency of coverage.

   Disadvantages:
   1. Not adaptable to rolling hills.
   2. Loss of water to wind.
   3. $60,000 initial cost.

Drip irrigation system.

Advantages:
1. Water applied directly to the plant.
2. Weed control.
3. Low labor cost.
4. Easier harvest.

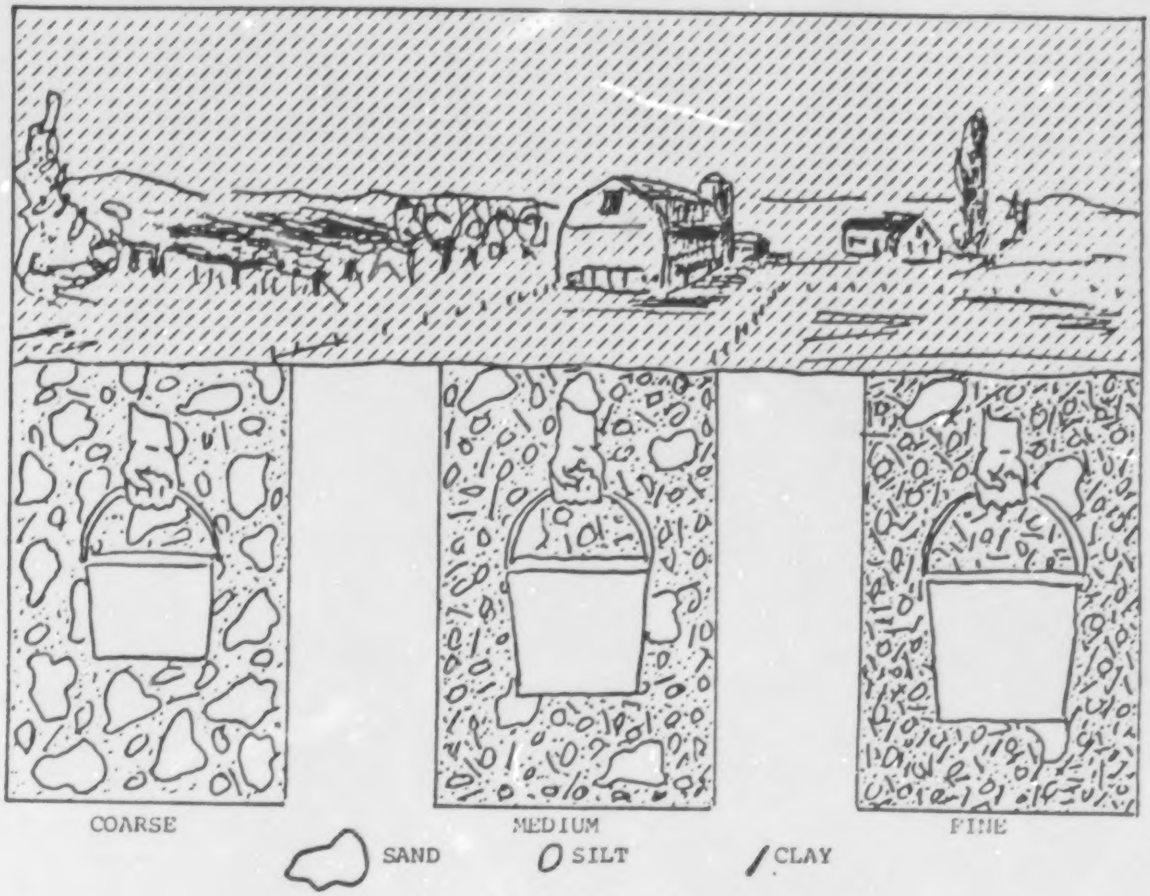
Disadvantages:
1. Plugged emitters.
2. Lack of a cover crop.


Rainfall Distribution in Washington (Inches)
Olympia
Yakima
Spokane
100
80
60
40
30
20
15
10

TM 22

TM 23

Soil Water Holding Capacity



The amount of sand, silt, and clay in a soil determine its texture. Soil texture has a large influence on the amount of water that can be stored in soils for plant use and the rate at which water moves through the soil. Familiarity with the soil texture on your farm will assist in making the irrigation job easier and more efficient.

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Harvesting

Unit XIII

Unit Goal: The student will become familiar with processes that occur during grape harvest.

Unit Objectives: Upon completion of the unit the student will be able to:

1. State when grape harvest takes place.
2. List the criteria used in determining when grape harvest should begin.
3. Use a refractometer in measuring soluble solids or brix in grapes.
4. Explain why concords can be mechanically harvested easier than wine grapes.
5. List reasons why some wine grape varieties are hand picked.
6. Explain the conditions necessary for mechanical harvesting.
7. Describe the stemmer-crusher and the purpose of adding SO_2 to the crusher.
8. Interpret by reading tables the projected harvest date for wine grapes.
9. Determine why many vineyard managers have trouble securing hand pickers for harvest.

Unit Content Outline:

I. Harvest Time.
    A. September to October.
    B. Concords.
        1. Soluble solids (brix).

- C. Wine grapes.
    - 1. Soluble solids.
    - 2. Acidity.
- D. Method of brix measurement.
    - 1. Refractometer.

II. Harvesting Methods.

- A. Concords.
    - 1. Hand picked.
    - 2. Mechanically picked.
    - 3. Condition of berry not important.
- B. Wine grapes.
    - 1. Hand picked.
        - a. reasons.
    - 2. Mechanical harvesting.
        - a. time.
        - b. accommodations.
        - c. crusher-stemmers.
        - d. SO_2.
    - 3. Projected harvest dates.
    - 4. Variety-ease of harvest and amount of juicing.
    - 5. Harvest conflicts.

Suggested Activities:

--Take brix readings of mature grapes with a refractometer.

--Observe a mechanical harvester in operation.

Information Sheet

Harvesting

The harvest season generally begins in late September. Harvesting is generally completed by the end of October.

Harvest time, generally, is controlled by the soluble solids content of the grapes. Concords are harvested based upon the degree brix or soluble solids. Normally, the brix for harvest of concord grapes begins at 15-18° brix and for wine grapes the brix may be 19-24° brix or higher.

A refractometer is often used to measure the percent sugar. Juice can be taken from a berry and onto the glass prism of the refractometer. The reading will give you a measure of the the soluble solids. Field readings can be taken with a refractometer. One must be careful to take a number of random samples when running a field test for sugar content. (See TM 24)

Grapes are either hand picked or mechanically harvested. Grapes are mechanically harvested to reduce labor costs and get grapes to the processor rapidly. Often a farmer does not have a choice as to the harvest method he uses. Many older vineyards are not adaptable to mechanical harvesting because of the trellising method used.

Concord grapes are hauled to market in bins (hand picked) or hoppers (mechanically). The skins of the grapes are used to give the juices and jellies their color.

Wine grapes are hand picked into lug boxes containing 36 pounds or into half bins which hold 400 pounds. The half bins are used to prevent the grapes from being crushed. It is important to prevent juicing thus eliminating the chance of oxidation that will result in a discoloration of wine.

Ideally, mechanical harvesting of wine grapes is done between 10 p.m. and 10 a.m. Grapes tend to be easier to harvest when the berries are more turgid and also helps prevent bacterial spoilage due to high temperature (above 72°F). Vineyard managers must be careful to assure the area between the rows is smooth, flat, and firm to facilitate the harvester. Mechanical harvesters are not designed to work on slopes of greater than 7 percent. Overhead sprinklers should be attached to posts and sprinkler heads removed so that they are not broken off.

The distance to the winery determines the field method of mechanical harvesting. If the winery is close by the grapes are loaded into lined full bins and transported to the winery. A crusher-stemmer is used when the transport distance to the winery takes a great deal of time. The crusher-stemmer is used to remove the stems from the berry.

Growers should protect white grape varieties from browning and oxidation by adding SO_2 to the crusher at harvest. Red varieties can also use SO_2 to help reduce bacterial spoilage that can occur at temperatures above 72°F.

Dr. Wade Wolfe has projected harvest dates for eleven varieties of wine grapes as seen in Table 14.

Table 14. Projected Harvest Dates for Popular _Vitis vinifera_ Cultivars in South Central Washington State.

	15 Sep.	Sep. 20	Sep. 30	Oct. 10	Oct. 20	Oct. 30	Nov.
Chardonnay				—	—		
Chenin blanc					—	—	—
Gewurztraminer		—	—	—			
Muscat blanc		—	—				
Sauvignon blanc			—	—			
Semillon				—	—	—	
White Riesling				—	—	—	
Cabernet Sauvignon				—	—	—	
Grenache				—	—	—	
Merlot			—	—	—		
Pinot noir	—	—	—				

The ease at which a grape variety is harvested may often be its justification for being mechanically harvested. A low-juicing, easily harvested variety may deliver as much tonnage to a winery as if it had been hand picked. Heavy-juicers and hard-to-pick varieties may be best harvested by hand. Table 15shows the eleven most popular wine varieties and their ease of harvest and the amount of juicing.

Table 15. Ease of Harvest and Amount of Juicing for Wine Grapes.

Variety	Ease of Harvest	Amount of Juicing
Chardonnay	Medium	Medium
Chenin blanc	Medium	Medium
Cewurztraminer	Easy	Light
Muscat blanc	Hard	Heavy
Sauvignon blanc	Medium	Medium
Semillon	Medium-Hard	Heavy
White Riesling	Medium	Medium
Cabernet Sauvignon	Easy-Medium	Light-Medium
Grenache	Hard	Medium-Heavy
Merlot	Variable	Variable
Penot noir	Medium	Medium

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Test

Harvesting

1. Match:

____a. 16° brix

____b. 24° brix or above

____c. Refractometer

____d. Mechanical harvesting

____e. SO_2

____f. Crusher-stemmer

____g. Sept. thru Oct.

____h. 10 p.m. - 10 a.m.

1. Used to measure the soluble solids.
2. Concords are harvested at this level of soluble solids.
3. Reduced oxidation in wine grapes.
4. The ideal time for wine grape harvest.
5. Wine grapes are harvested at this level of soluble solids.
6. Often used to reduce labor costs and speed up harvesting.
7. The months of grape harvest.
8. Removes stems from grapes.

2. Select the following statements that are correct.

____a. The % soluble solids and brix are used to measure sugar content of grapes.

____b. Oxidation of wine grapes is not important to the color of the wine.

____c. A crusher-stemmer is used to measure brix.

____d. Brix and acidity are both considerations in determining harvest dates for wine grapes.

____e. The skins of concords give the juice the color.

____f. The terrain of the land is not important in mechanical harvesting.

____g. The distance from the winery is an important consideration in whether a crusher-stemmer should be used in the vineyard.

3. Explain the field test for sugar content using the refractometer.

4. List two advantages of mechanical harvesting.

5. a. Why is it important to prevent juicing of wine grapes during harvest?

   b. Why should wine grapes be harvested between 10 p.m. and 10 a.m.?

6. Using Table 14, determine when White Rieslings will be harvested.

7. Using Table 15, determine which of the varieties would be better off hand picked. Why?

Answer Sheet

Harvesting

1. 1 a.
   5 b.
   1 c.
   6 d.
   3 e.
   8 f.
   7 g.
   4 h.

2. a, d, e, g.

3. Juice from berries of random cluster samples should be put on the prism. The reading will give you the brix.

4. a. Reduced labor costs.

   b. Gets grapes to the processor rapidly.

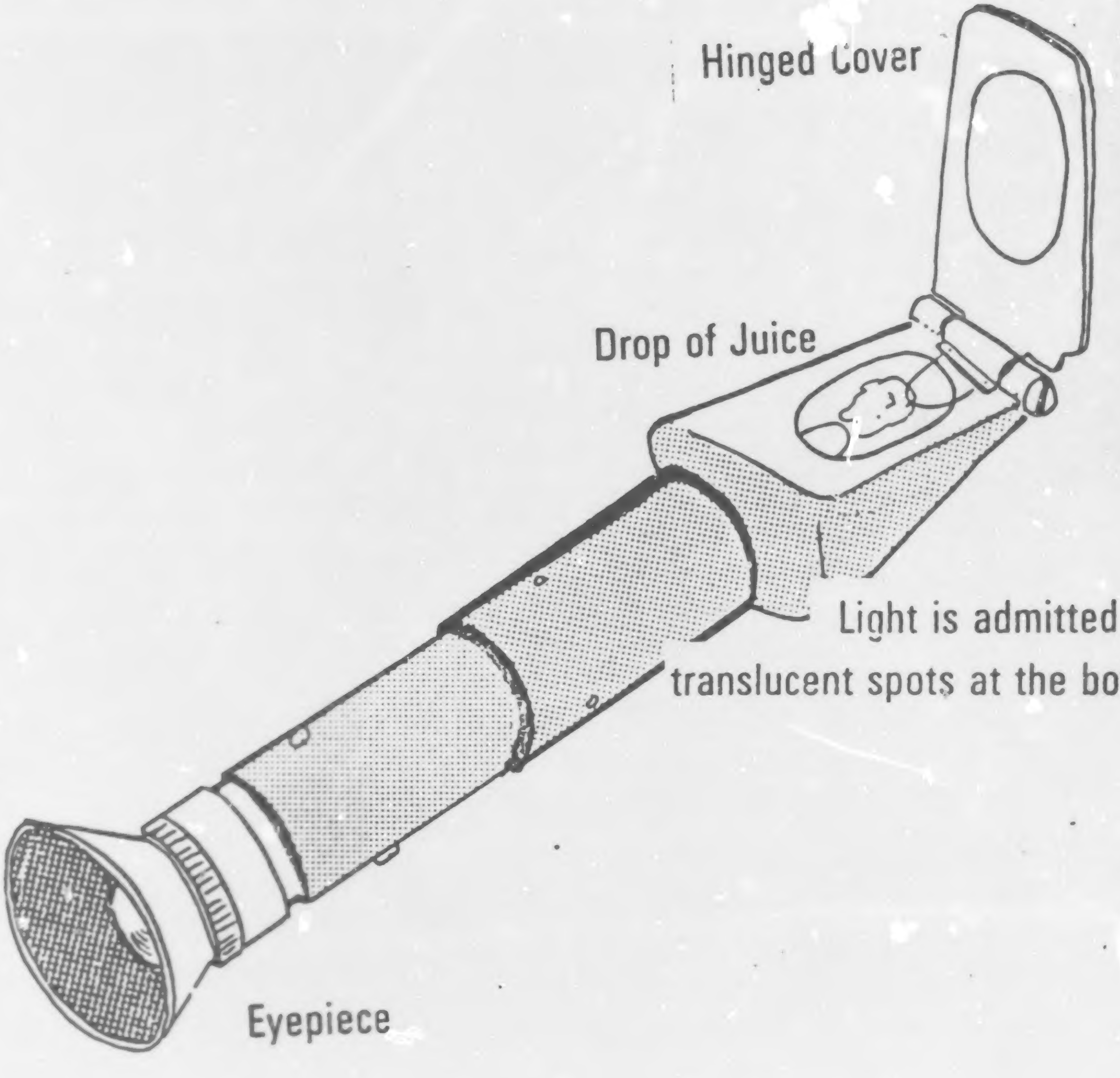
5. Juicing of wine grapes enhances the change of oxidation which will result in discoloration of the wine.

6. From approximately Oct. 15 - Nov. 5.

7. Muscat blanc because it is hard to mechanically harvest and juices easily thus much of the juice may be lost and the total tonnage reduced.

TM 24

Refractometer


Hinged Cover
Drop of Juice
Light is admitted th
translucent spots at the bott
Eyepiece

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Grape Processing and Product Marketing

Unit XIV

Unit Goal: Upon completion of the unit, the students will be able to understand the processes of making grape juice and wine.

Unit Objectives: Upon completion of the unit, the student will be able to:

1. List the two most important grape products of Washington State.
2. Describe the steps take in the production of grape juice.
3. Describe the steps take in in the production of white wines.
4. Describe the steps taken in the production of red wines.
5. List and describe sources of buyers for grapes.
6. Define the three types of table wines.

Unit Content Outline:

I. Two major grape products.
    A. Juice.
        1. Concords.
    B. Wine.
        1. European varieties.

II. Grape Juice Production.
    A. Weighing.
    B. Unloading.
    C. Destemming.
    D. Receiving tank.
    E. Heating.
    F. Collecting tank.

    - G. Press.
    - H. Filtering.
    - I. Pasteurization.
    - J. Bulk juice.
    - K. Other products.

III. White Wine Production.

    - A. Definition.
    - B. Crushing.
    - C. Destemming.
    - D. Must.
    - E. Fermenting tank.
    - F. Free-run juice.
    - G. Hard-press juice.
    - H. Clarification.
    - I. Chilling-vining.
    - J. Filtering.
    - K. Aging.
    - L. Filtering.
    - M. Bottling.

IV. Red Wine Production.

    - A. Two major differences.
    - B. Crushing.
    - C. Destemming.
    - D. Fermentation.
    - E. Free-run juice.
    - F. Hard-press juice.
    - G. Malo-lactic fermentation.

H. Racking-aging.

I. Fined.

J. Filtered.

K. Bottled.

Suggested Activities:

--Accumulate a list of products made from grapes.

--Tour a local winery or grape juice processing plant.

--Crush some grapes and show the students what the results will be if the juice is not pasteurized.

Information Sheet

Grape Processing and Product Marketing

Grape harvest occurs in the fall of the year for both American and European grape varieties.

The two most important products that we are concerned with are grape juice from concords and wine from European grape varieties.

Upon receiving the concord grapes at the processing plant, the grapes are weighed and a test is taken to determine the sugar content. These two items are used to make payment to the farmer.

After unloading, the grapes are destemmed. The grapes then proceed to the receiving tank. At this time, the juice is heated and sent to a collecting tank. A paper product is added to the tanks to act as a pressing agent. The skins of the grapes would not press properly for juice extraction unless the pressing agent were added. The juice is then sent through a continuous press which derives juice and purple color by extracting it from the skins.

Filtering of the juice is the next step completed to remove any solid or foreign particles from the juice. Pasteurization is done to kill any bacteria and yeasts that may induce fermentation. The juice is then refrigerated at 28°F to prevent any organisms from being active and again causing fermentation. Unlike wine making, fermentation is an undesirable in making grape juice.

The bulk juice is then used to make other grape products such as grape concentrates, drinks, juices, and jellies.

Refer to TM 25 for the flow chart of the grape juice process.

The product of grape juice fermentation by yeast is called wine. As yeasts work, they convert the sugars into alcohol and corbon dioxide. Normally, a 22% sugar grape will convert to half that percentage in alcohol or 11% alcohol.

After crushing and destemming, the skins and juice, known as "must," are placed in a fermenting tank. Here, the red grape varieties are placed for a longer period of time so that the red color can be extracted from the skins. The white varieties do not need exposure to the skins since a clear white color is often desirable.

White wine production will now be discussed separately from red wine production.

The "must" gives "free run" juice or the juice that separates itself from the skins. The skins are then pressed again to get "hard press" juice. At this time, the free run and hard press juices are put in stainless steel tanks. In order to control fermentation wine yeasts are now added. White wines are generally fermented at temperatures of 45°-65°F for 2-4 weeks in order that they will maintain desirable aromas.

The wines are then clarified by a centrifuge. The wine is chilled to 26°-32°F in order for solids and tartaric acid to settle out. Sulfur dioxide is also added. This along with the chilling will leave the sugar at a desirable level.

The wine is now filtered and stored in wood or stainless steel cooperage for 3-18 months. The wine is again filtered and bottled. The whites are aged in the bottles for up to 6 months and then released for sale to the public.

Refer to TM 26 for the flow chart on white wine production.

There are two major processes that make the production of red wines different from white wines. Tannins which impart the bitter tastes and the color must be extracted from the skins. Thus, fermentation is done with the skins in producing red wines. Fermentation takes place at temperatures of 70°-80°F to bring out characteristics other than the fruity character of the grape.

The must of red varieties is put in fermenting tanks and the yeast is added. Free-run juice then goes through malolactic fermentation. Reds, unlike white wines, are put through this process. The process tends to reduce the amount of acid in the wine. Consumer appeal dictates this process as consumers tend to like white wines of higher acid content. Malolactic fermentation converts malic acid to lactic acid. This process takes three weeks to one month to complete.

After fermentation is completed the wine is racked into wood cooperage. The cooperage varies from 50-60 gallon oak barrels to 8,000-16,000 gallon redwood tanks.

Depending on the variety of grape, the wine is aged from 2 months to 3 years. After aging they are fined, filtered, and bottled.

Refer to TM 27 for the flow chart on red wine production.

Grape marketing for the raw product and processed product is and will continue to be a top priority for farmers and processors in Washington State.

Farmers currently sell their product to cash buyers, cash brokers, and contract buyers.

Cash buyers purchase grapes without a written contract. If the cash buyer is having trouble marketing the processed grape product, then they have the option of telling the grower they will not purchase the crop the next year.

Contract buyers are obligated to purchase grapes produced on the acreage specified on a written contract.

Cash brokers act somewhat as a middleman. They will purchase the raw product and distribute it to organizations that process the grapes into wine or juice.

Current supply and demand dictate prices that farmers will receive for their grapes.

Bulk grape juice is used to produce grape juice, jelly, drink, and concentrate.

Most Washignton State wine grapes are used to produce table wines. Table wines usually have 14% or less alcohol and can be further classified into varietal, generic, and mod or pop wines.

Mod wines are usually made of grape and non-grape bases. They often contain artificial flavoring.

Generic wines are a blend of two, three, or more grape varieties and carry the name of a European wine producing area such as burgundy or champagne.

Varietal wines must be at least 75% of the variety that is seen on the label. Labels that name a specific geographic location must be 100% of the variety and the grapes must have been grown in that specific location. For example, a label may read Chardonnay, Yakima Valley.

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Name ____________________

Test

Grape Processing and Product Marketing

1. Match:

____a. Pasteurization

____b. Skins

____c. Malolactic fermentation

____d. Must

____e. Wine

____f. 45°-65°F

____g. Red wine

____h. Pressing agent

____i. 70°-85°F

____j. Free run

____k. Color

____l. Filtering

____m. Alcohol

____n. Fermentation

____o. Clarification

____p. Bitter

1. The primary product of European type grapes.

2. A process used to destroy bacteria yeasts.

3. The purple color of juice is derived from the ____.

4. Yeasts convert sugar into CO_2 and ___.

5. Refrigeration of grape juice will aid in preventing ______.

6. A centrifuge is used for __________.

7. Red wines are put through this process whereas very few whites are.

8. A term given to the skins and juice after crushing and destemming takes place.

9. The paper product added at the collecting tank when making juice is referred to as a ________.

10. Red wines are fermented at these temperatures.

11. White wines are fermented at these temperatures.

12. Tanning impact this taste in red wines.

13. This type of wine is usually stored 2 months to 3 years before it is bottled.

14. The type of juice that separates itself from the skins without being pressed.

15. The processing wine making that removes solid or foreign particles.

16. Red varieties are processed in the presence of their skins to derive ______.

2. Select the following statements that are correct.

____a. Farmers receive payment according to weight and sugar content of the grapes.

____b. Bulk juice is used to make grape concentrates, drinks, juices, and jellies.

____c. Pasteurization is done in wine making to help in fermentation.

____d. Wine yeasts are added in wine making so that fermentation is controlled.

____e. High fermentation temperatures will bring out the fruity characteristics in grapes.

3. Complete the missing steps in grape juice production.

a. Weighing.

b.

c. Destemming.

d. Receiving tank.

e. Heating.

f.

g.

h. Filtering.

i.

j. Bulk juice.

k. Other products.

4. Essay:

   Why is malolactic fermentation done to red wines and hot white wines?

5. Define the following terms related to grape marketing.

   a. Cash buyers -

   b. Contract buyers -

   c. Cash brokers -

   d. Generic table wines -

   e. Mod or Pop wine -

   f. Varietal wine -

Answer Sheet

Grape Processing and Product Marketing

1. Match:

   2 a.
   3 b.
   7 c.
   8 d.
   1 e.
   11 f.
   13 g.
   9 h.
   10 i.
   14 j.
   16 k.
   15 l.
   4 m.
   5 n.
   6 o.
   12 p.

2. a, b, d.

3. b. Unloading.
   f. Collecting tank.
   g. Pressing.
   i. Pasteurization.

4. Consumers prefer white wines with higher acidity than red wines. Malolactic fermentation will lower the acidity of the wine.

5. a. Cash buyers - purchase grapes without a contract.

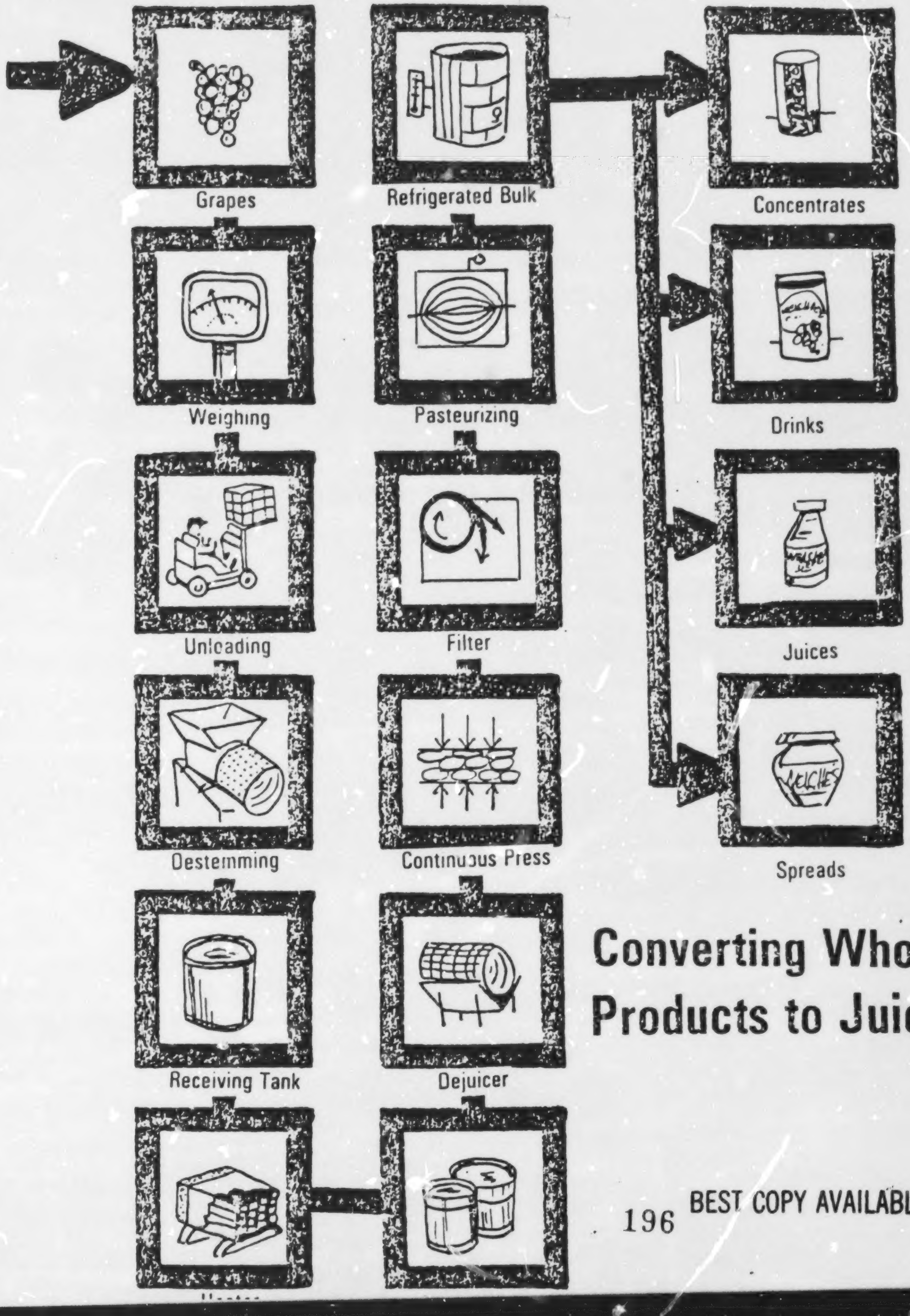
   b. Contract buyers - purchase grapes on a written contract based on acreage.

   c. Cash brokers - purchase grapes without a written contract and distribute to processing plants.

   d. Generic table wine - a blend of two, three, or more grape varieties.

   e. Mod or Pop wine - made of either a grape or non-grape base and often contains artificial flavor.

   f. Varietal wine - must be at least 75% of the variety that is seen on the label.


Grapes
Weighing
Unloading
Destemming
Receiving Tank
Dejuicer
Continuous Press
Filter
Pasteurizing
Refrigerated Bulk
Concentrates
Drinks
Juices
Spreads

Converting Whole Products to Juice

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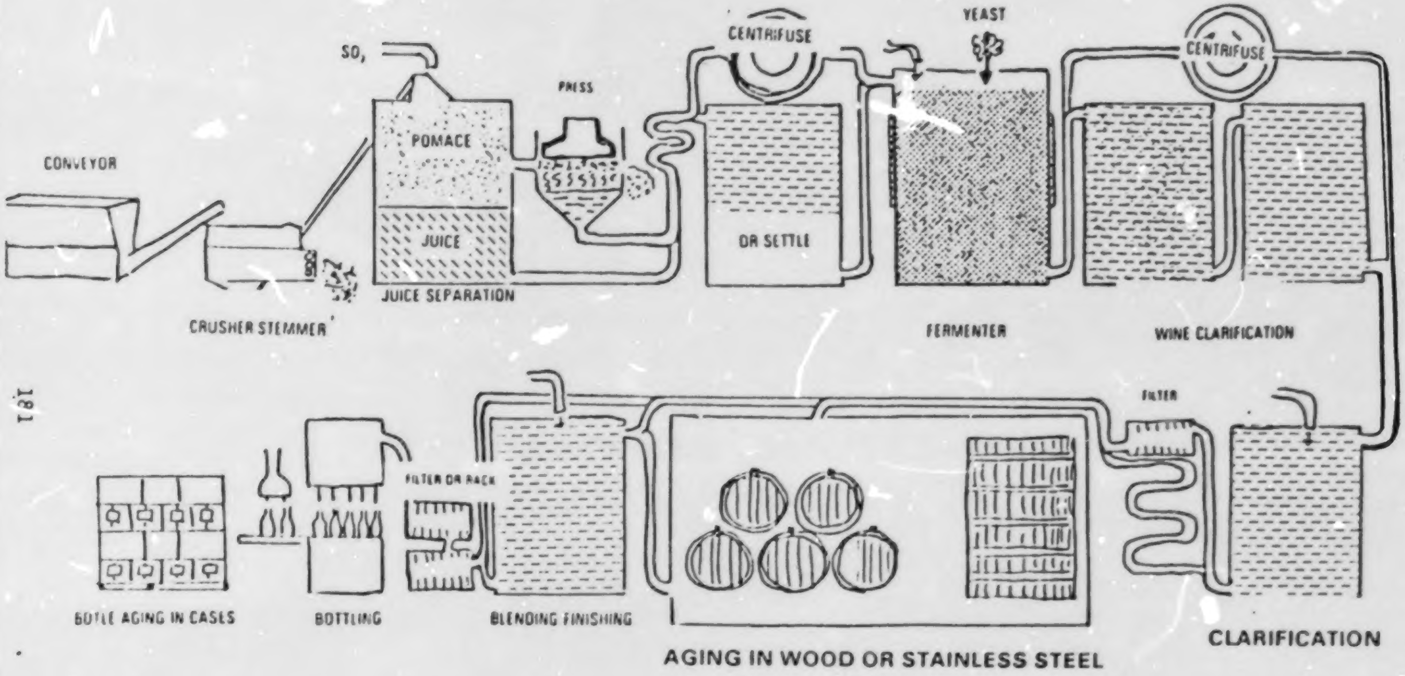
White Wine Production


CONVEYOR
CRUSHER STEMMER
SO,
POMACE
JUICE
JUICE SEPARATION
PRESS
CENTRIFUSE
OR SETTLE
YEAST
FERMENTER
CENTRIFUSE
WINE CLARIFICATION
FILTER
CLARIFICATION
AGING IN WOOD OR STAINLESS STEEL
FILTER OR RACK
BLENDING FINISHING
BOTTLING
BOTLE AGING IN CASES

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TN 26

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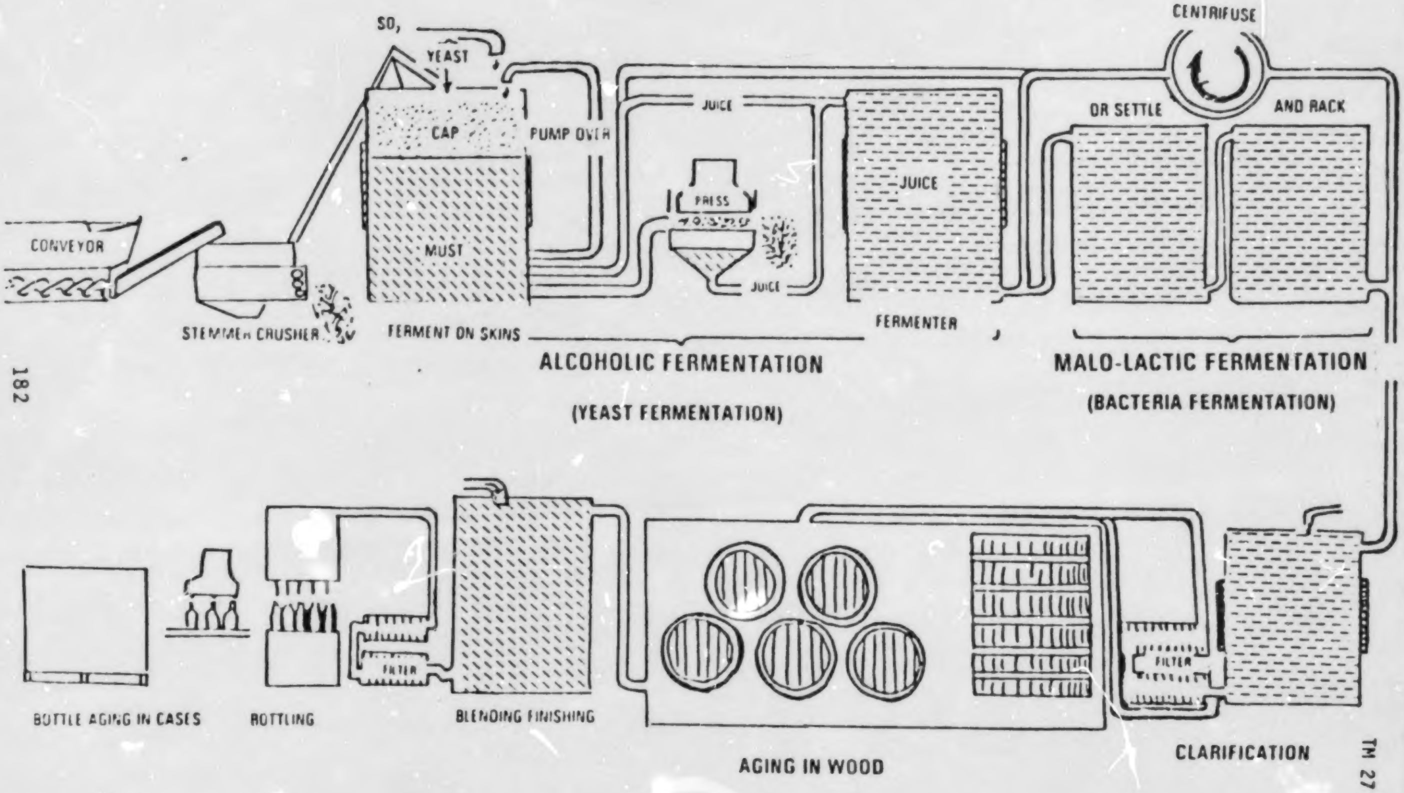
Red Wine Production


SO,
YEAST
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MUST
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JUICE
PRESS
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CENTRIFUSE
OR SETTLE
AND RACK
CONVEYOR
STEMMER CRUSHER
FERMENT ON SKINS
FERMENTER
ALCOHOLIC FERMENTATION
(YEAST FERMENTATION)
MALO-LACTIC FERMENTATION
(BACTERIA FERMENTATION)
FILTER
FILTER
BOTTLE AGING IN CASES
BOTTLING
BLENDING FINISHING
AGING IN WOOD
CLARIFICATION

TM 27

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